Constructive Chaos:
Case Study of Student Learning
in a Grade 5
One-to-One Computing Environment

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By

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Abstract

Educators are being asked to transform traditional pedagogy to include strategies, resources and tools to accommodate 21st century learning (Jacobs, 2010; Stansbury, 2010; U.S. Department of Education, 2010). This thesis analyzes strategies used in a grade five one-to-one learning environment to enrich learning and accommodate 21st century skills. Analysis of qualitative data is provided through a detailed description of emergent information within a case study. Results are presented on three specific strategies used to enrich learning within the technology-based environment. The findings may be useful not only to teachers but administrators, leaders and instructional designers within the educational field.

21st Century teaching and learning presents a holistic view, combining key elements including: core subjects, learning and innovation skills, information, media and technology skills and life and career skills (Partnership for 21st Century Skills, 2004). "The 21st Century learning model calls for significant paradigm shift in what is taught, how it is taught and how progress is assessed" (21st Century Learning Associates Inc., 2010). The transformation to integrate technology-based learning with pedagogy, although essential to the 21st Century learning model (21st Century Learning Associates Inc., 2010), may be leaving a number of educators "stuck" not understanding what is being asked of them or where to begin.

In an attempt to better understand instructional and learning processes used for 21st Century teaching and learning, this research study focuses on three strategies: one-to-one (1:1) computing, instructional design (ID) and differentiated instruction (DI). Strategies are analyzed on the enrichment effect each of the variables have on a grade five learning environment for the development of 21st century skills.

Qualitative participant data are presented through a case study approach. The qualitative data analysis software Nvivo9™ is used to organize and categorize jumbled results of semi-structured interviews, direct classroom observations and documentation.

Results of the research study are descriptive in nature characterizing, how each of the three strategies (1:1 computing, ID and DI) influenced teaching and learning within the grade five technology-based learning environment. Processes (instructional and learning) are highlighted as a result of the research study.

One may view this thesis as an instructional design thesis, drafting a blueprint for enriching instruction within a technology-based learning environment. Teachers, educational leaders, instructional designers and others involved with 1:1 computing, ID and DI may find the results of this thesis significant to assist with a holistic view towards 21st century teaching and learning.

Acknowledgements

In completing this research study I was able to get through it, as the The Beatles in 1967 wrote, “With A Little Help From My Friends.”

First I would like to thank my graduate supervisor, Dr. Dirk Morrison for his direction, support, edits, and thought-provoking conversations. Although, it cost me a few lunches, it was well worth it. Second I would like to thank my graduate committee of Dr. Len Proctor (Chair), Dr. Richard Schwier, Dr. Jay Wilson, and Dr. Ivan Kelly. I appreciate the time and efforts you provided in helping me complete my M.Ed.

The next group that I need to thank is the one-to-one project participants. This includes the grade five students who participated in the one-to-one learning environment and team members including: Robert Nysteun, Sharon Farley, and Randy Steciuk. Your support, efforts and dedication to this project made it more than what I could possibly imagine.

A special thank you goes out to my wife Bev Kezema. As the classroom teacher for this project you not only had to deal with me at work but also at home. Thank you for being such a positive influence on, not only our children, but all the children you teach. I hope this experience was as valuable to you as it was to me.

Finally, what kind of son would I be if I didn’t include Mom and Dad? The two of you have provided me with the support and love making me the man I am today…Thank you!

Dedication

This thesis is dedicated to my two precious daughters, Jorja and Lauryn. Thank you for motivating me to do my part in transforming education to allow for more engaging learning experiences. P.S. I can't wait to see the dresses you are wearing for my convocation!

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Chapter 1: Introduction

Introduction to the Problem

> When I am asked to describe what I saw on my last visit to Uruguayan schools in December, I usually respond with one word: 'chaos.' I did not mean this (necessarily) in a negative sense, but rather to note that, when all children have laptops and when teachers are given the freedom to explore with those students how best to use them, some of the traditional ways of organizing and managing a classroom are greatly challenged (Trucano, 2010).

In an attempt to infuse technology into curriculum, formal education systems, including both school divisions and government, continue to invest money on innovative technologies (Cuban, 2000; Pelgrum, 2001). The history of technology-based learning provides a perspective of change, from where it started to where it has evolved. Reports suggest that technology-based learning plays a major role in enabling the education system to motivate and inspire students through the creation of outcome-based, authentic learning experiences and resouces (U.S. Department of Education, 2010; Willms, Friesen, & Milton, 2009). A theory discussed by Weston and Bain (2010) suggests a vision where "laptop computers are not technological tools; rather, they are cognitive tools that are holistically integrated (Senge et al., 2005) into the teaching and learning processes of their school (Bain, 2007)" (p. 11). There appears to be increased support identifying that one-to-one computing initiatives are necessary to provide desirable

learning environments for students. With that being said, the author contends that 21st century learning environments require a great deal more than simply adding ubiquitous computing in order to change classrooms into dynamic learning environments.

Although considerable technology investments have been made, it appears adoption of innovative technologies, into at least formal education systems, is slower than would be expected (Rogers, 2000; Zhao & Cziko, 2001; Looker & Thiessen, 2003). A speculated cause for slow adoption is the main focus on technology and not on teachers and their ability to authentically use technology (Stansbury, 2010). There is evidence of pre-service teachers having poor training in technology integration and instructional practices (Bebell, Russell, & O'Dwer, 2004; Kershaw & Kershaw, 2010; U.S. Department of Education, 2010). A mistake commonly made by educational administrators and teachers is an assumption that by simply adding computers or other forms of cognitive devices, technology will be effectively integrated into the classroom (Bebell & O'Dwyer, 2010). Similarly, there is a belief that teachers with basic computer literacy skills integrate computers into curriculum; however, the reality is often that they resort to infrequent use of computers or reward students with drill and practice computer activities (Lowther & Morrison, 1998; Rogers, 2000). Current research strongly indicates that the most important factor for successful technology integration into curriculum is the willingness for teachers to change pedagogy, in other words, more focus needs to be put on classroom practices and less on equipment (Stansbury, 2010; Weston & Bain, 2010).

A quick look back into the history of computers in the K-12 classroom shows the evolution of educational technology from computer classes to cognitive tools. The 1990s present a period in K-12 schools where basic computer skills were taught (Center for Digital Education, 2004). Students were taught basic terms relating to computers (e.g. RAM, ROM, and peripheral) (Jonassen, 1996). As operating systems became more user-friendly and software advanced, K-12 schools focused more on teaching software applications, including word processing, spreadsheet and presentation programs. More recently, with the shift of the web from a static or passive environment (Web 1.0), where users are the recipients of information, to a more collaborative environment (Web 2.0), where users are active participants of content creation, we see improved approaches for implementing technology-based curriculum and instruction into K-12 classrooms (Delich, 2005). This fundamental shift has stimulated a movement from learning *about* computers, to learning *with* computers (Center for Digital Education, 2004). It appears that "adoption of technology" is no longer about showing students how to use computers but rather to leverage the power of cognitive tools allowing for engaging and empowering learning experiences through complete, authentic and meaningful approaches (Weston & Bain, 2010; Partnership for 21st Century Skills, 2004).

New models of learning, such as The National Educational Technology Plan (NETP) or the Model of Learning Powered by Technology (U.S. Department of Education, 2010) identify that "the challenge for our education system is to leverage the learning sciences and modern technology to create engaging, relevant, and personalized

learning experiences for all learners that mirror student's daily lives and the reality of their futures" p. X. Some new learning models, including the Framework for 21st Century Learning (Partnership for 21st Century Skills, 2004) and the 21st Century Learning Model (21st Century Learning Associates Inc., 2010) are attempts to transform schools in order to provide students with 21st century skills, including learning and innovation skills and information, media, and technology skills, through technology-based learning (Jacobs, 2010; U.S. Department of Education, 2010; Willms, Friesen, & Milton, 2009). Traditionally, technology implementation has focused on tools and software. This has resulted in non-authentic (non curriculum and outcome related) attempts for technology-based learning to be implemented into curriculum and instruction. It has been suggested that some teachers may not understand how to design and effectively implement technology-based learning into curriculum and instruction to provide authentic learning experiences (Pitler, Hubbell, Kuhn, & Malenoski, 2007).

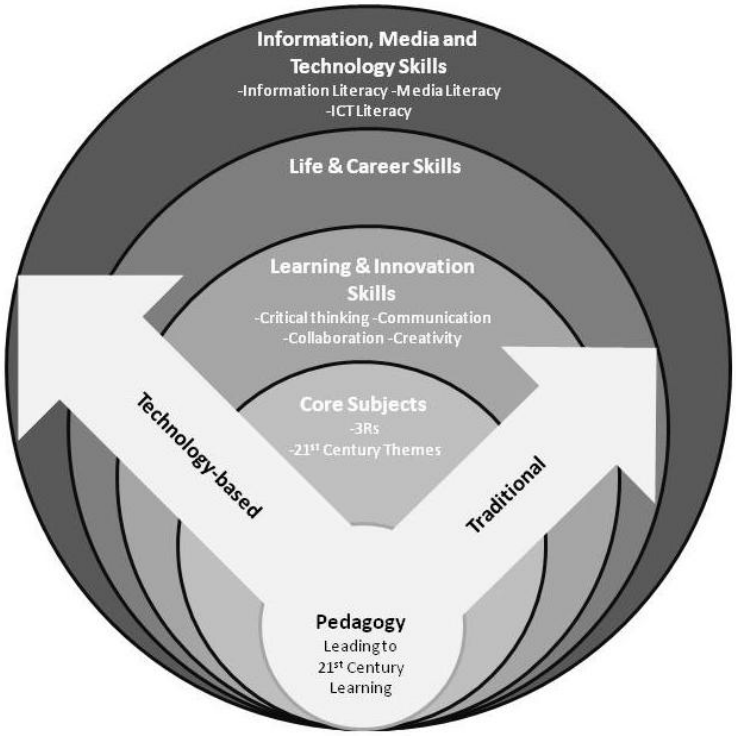

Figure 1: Traditional vs. Technology-based Curriculum and Instruction for 21st century learning

Figure 1 illustrates traditional vs. technology-based curriculum and instruction for 21st century learning. The main idea represented in the illustration is that the *design of curriculum and instruction*, through either traditional or technology-based methods, *consist of specific layers* and *require distinct strategies*.

At the centre is pedagogy, which provides the foundation for all curriculum and instruction. Pedagogy consists of layers which account for specific competencies of 21st century learning. Traditional pedagogy allows for most layers to be achieved except information, media and technology skills. Technology-based pedagogy permits all competencies of 21st century learning to be achieved including information, media and technology. It could be argued that information, media and technology are required for

much of the creativity, knowledge and innovation currently powering the world (21st Century Learning Associates Inc., 2010). A question raised with the traditional route is whether or not 21st century competencies can be achieved?

Most often, teachers are experienced and comfortable with designing curriculum and instruction for traditional learning environments. However, when asked to design curriculum and instruction for technology-based environments, they may hit a road block by not fully understanding what is being asked of them. Teachers are being asked to teach 21st century competencies, using real-world tools including wikis, blogs, digital research resources and digital collaboration and communication tools in order to prepare students for a globally competitive workforce (U.S. Department of Education, 2010; Willms, Friesen, & Milton, 2009; 21st Century Learning Associates Inc., 2010; Partnership for 21st Century Skills, 2004). Many teachers currently employed in our education system are 'digital immigrants' (Prensky, 2001). "Those of us who were not born into the digital world but have, at some later point in our lives, become fascinated by and adopted many or most aspects of the new technology are, and always will be compared to them, Digital Immigrants" (Prensky, 2001, p. 2). It is likely that designing curriculum and instruction for technology-based environments is so foreign to many of our teachers that they simply do not understand how to do it or where to begin.

A cognitive tool vision discussed by Weston and Bain (2010) identifies digital technology as a tool used to transform and accelerate educational practices and maximize student learning experiences. "Cognitive tools are examples of learning with

technologies rather than from them" (Jonassen D. H., 1995, p. 40). Strategies such as cooperative learning, differentiated instruction and problem/project-based learning are designed, delivered and managed through the assistance of digital cognitive tools. "Just as pencils, pens, papers, and books were the predominant tools for learning and knowledge production during much of the last century, computers and the Internet are the tools for learning and knowledge production in the 21st century" (Warschauer, 2006, p. 37). Similarly, comparisons have been made of one-to-one computing in the 21st century to the distribution of individual student text books between the end of the 19th century and beginning of the 20th century (Wilson & Peterson, 2006). Merrill (1994), in his Component Display Theory, would see cognitive devices as part of the 'macro strategies', which represent how information is delivered to the student. Envisioned through the cognitive tool discussion by Weston and Bain (2010) are transformed teachers, students, parents and schools focusing on authentic differentiation of student learning.

Authentic learning, in education, essentially focuses on providing curriculum and instruction through real-world, complex problems and their solutions over a period of time. Authentic learning environments are organized to include multiple disciplines, multiple perspectives, ways of working, habits of mind, and community using problem-based activities, case-studies, critical thinking, and collaboration (Lombardi, 2007; Herrington & Herrington, 2006; Herrington, Oliver, & Reeves, 2002). An approach to authentic use of cognitive tools is the implementation of one-to-one computing

initiatives. One-to-one computing continues to be exposed as one of the initial phases "toward improving the instructional process and, at the same time, improving student achievement" (Center for Digital Education, 2004, p. 3). Although the characteristics of one-to-one initiatives are defined by each institutional context, a common theme for the majority of recent initiatives, such as the 2003 and updated 2009 Main Learning and Technology Initiative (MLTI) and the New Brunswick 2004 and expanded in 2009 Notebook Initiative, is to provide students with access to mobile computers and wireless Internet. In a synthesis review of 30 separate studies, Penuel (2006) identifies three conventional features defining characteristics of one-to-one classroom initiatives to include: "providing students with use of portable laptop computers loaded with contemporary productivity software (e.g., word processing tools, spreadsheet tools, etc.), enabling students to access the Internet through schools' wireless networks, and a focus on using laptops to help complete academic tasks such as homework assignments, tests, and presentations" (p. 331).

As a result of failed attempts through traditional pedagogy, an effort to transform public education is a view held by a variety of groups and organizations. Canadian companies and educational organizations such as The Coalition for 21st Century learning and Innovation (C21 Canada) and Partnership for 21st Century Learning and Innovation (P21 Canada) have a mandate to advocate for 21st century learning models in public education (21st Century Learning Associates, 2011; Kershaw, 2011). C21Canada and P21 Canada are represented by companies and organizations including Apple, Cisco,

Dell, IBM, Microsoft, Nelson Learning, Pearson Education, Scholastic Canada, Smart Technologies, the Canadian School Board Association, Canadian Education Association, Toronto School Board Association, Education Research Development Incorporated (ERDI), York University's Institute for Research on Learning Technologies, 21st Century learning Associates and MindShare Learning (Kershaw, 2011). These coalitions suggest 21st Century competencies including creativity, critical thinking, communication, collaboration and culture should be infused into Canadian classrooms through integrating digital technology to engage the digital generation of students in their learning. The founding members of the coalition share the view that 21st Century models of learning are urgently required in public education to position students and Canada for success in the knowledge and digital age" (21st Century Learning Associates, 2011). "The Conference Board of Canada has also called for Canada to become a more innovative society, citing declining productivity performance relative to other developed countries as a troubling trend" (Kershaw, 2011).

As an attempt to begin understanding 21st century teaching and learning, in September of the 2010 school year, a school division in North Eastern Saskatchewan distributed a classroom set of netbooks to a class of grade five students at one of their elementary schools. This research study will attempt to describe enriched environments for teaching and learning 21st century skills through the implementation of three specific strategies namely: one-to-one computing, instructional design and differentiated instruction.

Purpose of this Study

The purpose of this study is to explore the enrichment of teaching and learning for providing 21st century skills to students in a grade five classroom through three distinct strategies. The *first* strategy of enrichment is the insertion of one-to-one computing into the learning environment. Small, lightweight, inexpensive ten inch laptop computers were used in the grade five classroom. This research will not evaluate the use of the netbooks per se; instead it will focus on what happened to teachers' approach to pedagogy and student learning in an environment where each participant was provided full-time access to wireless digital cognitive tools (e.g. netbooks, wireless Internet). The *second* strategy of enrichment is to incorporate principles of instructional design (ID) into the learning environment. Allowing full-time access to digital cognitive tools changes the medium (print-based vs. new media) in which teaching and learning transpires. Traditional forms of teaching and learning rely heavily on print-based materials and resources. When digital cognitive tools are available full-time, both teaching resources and learning activities can be designed around forms of new media (Internet, web-sites, blogs, video sharing, Facebook, Twitter). Technology-based learning allows for the adoption of high-quality interactive content, meeting individual student learning styles, to be incorporated into lesson design. Through skillful planning and design, interactive instruction, including student-focused learning objectives, assessments linked to learning objectives, and ability to practice skills can be incorporated into instruction (Mahon & Tishion, 2011). As a result, a core focus of this research is how instruction can be

designed when digital cognitive tools are implemented on a one-to-one basis. The *third* strategy this study explores, is differentiated instruction (DI). This research study explores how strategies of DI are designed into technology-based instruction within a one-to-one learning environment.

During the data analysis, each of the three implementation strategies for enrichment of student learning (Figure 2) including one-to-one computing, instructional-design theory, and differentiated instruction, become the data sources to provide findings for this research study. In isolation, each of the strategies may offer benefits to a learning environment. However, this study will focus on the dynamic interactions among these three strategies to distinguish how a student's learning environment can be enriched to accommodate 21st century skills. Each of the three strategies was chosen for its dynamic effect on the learning environment. Differentiated instruction provides instructional and learning strategies popular with many educators. One-to-one computing allows for the integration of technology-based learning meeting all layers of 21st Century competencies. Instructional design allows instruction to be thoroughly designed and grounded in learning theory.

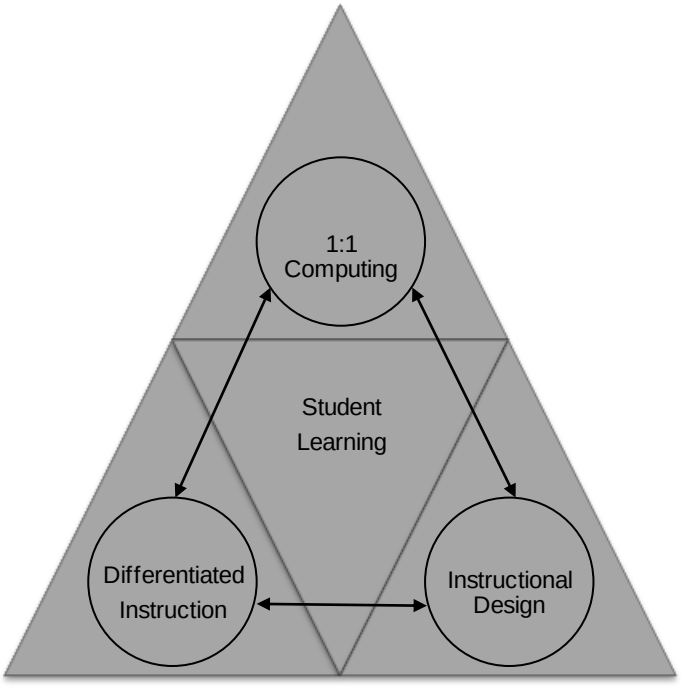

Figure 2: Strategies for Enrichment of Student Learning

Main Objective of the Research

Case study findings help to better understand teaching and learning in one-to-one environments. Although it is believed that findings relating to one-to-one implementation, technology-based learning, and physical space (one-to-one environment) may be found; the 'grand tour' question (Marshall & Rossman, 1989) explored in this study is:

- This research does not hypothesize, however, speculates there is no correlation (do not share variance) between one-to-one computing (1:1), instructional design (ID), and differentiated instruction (DI). Keeping the speculation in mind, what is the significant enrichment effect each of the

three variables, under investigation, has on a grade five learning environment for the development of 21st century skills?

Sub-questions (Miles & Huberman, 1984) this study will focus on:

- How do *instructional processes and pedagogy* differ in a technology-based learning environment in contrast to traditional learning environments?
- What can we learn about the *design of instruction* in a one-to-one computing environment as compared to traditional classroom-based learning environments?
- What is the *process of instructional design* regarding *learning resources* as they are utilized through one-to-one computing environments?
- How can *instruction be designed* in a one-to-one environment incorporating *differentiated instruction*?

Significance of the Study

One-to-one computing is 'coming of age' or maturing throughout many K-12 educational systems throughout the world including Canada and the United States (Suhr, Hernandez, Grimes, & Warschauer, 2010; Wilson & Peterson, 2006). A school division, located in Northeast Saskatchewan, has piloted the offering of one-to-one computing by providing netbooks to a class of grade five students. Knowledge gained and lessons learned through the experience and analysis of the pilot is necessary for both the school division and other educational institutions directing future initiatives and resources at

one-to-one learning environments. Also the research findings from this study will be meaningful for a variety of stakeholders including teachers, parents, principals, superintendents, directors, board members and other educational leaders and planners. Finally, this research study will add to the limited scholarly research and literature available to help improve practice and policy relating to the design and enrichment of 21st century learning through one-to-one computing, instructional design and differentiated instruction. Strategies analyzed in this study provide a unique combination and perspective towards enriching student learning. The case study format of this research allows for qualitative data to be presented which may provide insight into real-life scenarios necessary for others to understand experiences and gain knowledge.

Definitions

The following terms are defined in order to provide the reader a better understanding of the terms used in this study.

Authentic Learning –Tiered learning associated with real-world relevance and utility of complex problems, completed over a sustained period of time, that integrate across the curriculum, using problem-based activities, case studies, critical thinking and collaboration (Lombardi, 2007; Herrington & Herrington, 2006; Herrington, Oliver, & Reeves, 2002).

Cloud Computing – Computer services delivered via the Internet, as cloud computing encompasses more that web applications and data storage (Ward, 2011).

Cognitive Tools – State-of-the-art devices, generally computer tools that learners use to engage and facilitate cognitive processes (Jonassen, 1994). Later identified by Jonassen (2006) as "mindtools" and defined as "computer-based tools and learning environments that have been adapted or developed to function as intellectual partners with the learner in order to engage and facilitate critical thinking and higher-order learning" (p. 9).

Differentiated Instruction (DI) – "Effective instruction that is responsive to the diverse learning needs and preferences of individual learners" (Hume, 2008, p. 1). DI is an approach that tailors or modifies instruction to help meet the diverse academic needs and learning styles of individual students (Learning Point Associates, 2007).

Formative Assessment – Diagnostic assessment performed regularly throughout the course of instruction to inform and alter teaching and learning to meet student needs (e.g. teacher observation, classroom discussion) (Boston, 2002).

Innovative Technologies – State-of-the-art devices which assist with new ways of doing things to bring about continuous improvement (Smith, 2009).

Instructional Design (ID) – Process of maximizing the effectiveness, efficiency and appeal of instruction through analysis of learning needs and systematic development of learning resources (Culatta, 2010). Reiser (2001) defines ID including the term technology to "…encompass the analysis of learning and performance problems, and the design, development, implementation, evaluation and management of instructional and

non-instructional processes and resources intended to improve learning and performance in a variety of settings, particularly educational institutions and the workplace" (p. 53).

One-to-One Computing – Ratio of one wireless, mobile computer per student.

One-to-One Learning Environment – Learning environment where each student is provided with a wireless mobile computer continuously throughout the school day (Center for Digital Education, 2008).

Response to Intervention (RTI) – "Response to intervention integrates assessment and intervention within a multi-level prevention system to maximize student achievement and reduce behavior problems. With RTI, schools identify students at risk for poor learning outcomes, monitor student progress, provide evidence-based interventions and adjust the intensity and nature of those interventions depending on a student's responsiveness, and identify students with learning disabilities" (National Center On Response To Intervention, 2011).

Summative Assessment – Activities performed by teachers and students to judge learning after a period of instruction (e.g. grading a test or paper) (Boston, 2002).

Technology-based learning – Learning facilitated and enhanced through state-of-the-art devices.

Technology Integration – Classroom use of state-of-the-art devices for the purpose of teaching and learning (Rogers, 2000).

21st Century Learning – a blend of student outcomes including core subjects (reading, writing and arithmetic), learning and innovation skills (creativity and innovation, critical thinking and problem solving, communication and collaboration), information, media and technology (information literacy, media literacy, ICT literacy) with innovative support systems (standards, assessment, curriculum and instruction, professional development and learning environments) to help students master the multi-dimensional abilities required of them in the 21st century (Partnership for 21st Century Skills, 2004).

Ubiquitous computing – learning environments in which all students have access to a variety of digital devices and services, including computers connected to the Internet and mobile computing devices…"and includes the idea of technology being always available but not itself the focus of learning" (Research Center for Educational Technology, 2006).

Universal Design for Learning (UDL) – "A set of guidelines and principles to guide the development of curriculum and instruction enabling equal opportunities for all individuals to learn" (CAST, 2010; Hall, Strangman, & Meyer, 2003).

Value of Investment (VOI) – Calculation to determine if a project is worth the cost. "VOI = (Total $ Benefit + $ value of Total Score) / Total Cost multiplied by 100%. VOI greater than 100% has a positive value with the highest VOI providing the best projected return on investment" (Wilson & Peterson, 2006, p. 6).

Delimitations and Limitations

This section will discuss both the delimitations and limitations of this research study.

Delimitations. This study focused on a particular set of grade five students, participating in the one-to-one digital literacy project. Primary data were captured through in-depth case study of specific grade five students situated in the one-to-one learning environment. Research data were gathered through qualitative collection processes, including: direct observations and semi-structured interviews. Observational and interview data collected from teachers, differentiated instructional facilitator (DIF), principal and digital learning consultant(s) (DLC) present triangulated support of the research findings. The researcher of this study is the Digital Learning Consultant (DLC) directly leading the research project.

Limitations. In this qualitative case study, findings may be constrained by the following limitations:

1. Data collection was not random but rather intentional; data were gathered from specific students in the classroom, not taking into account any factors other than student engagement and learning that appeared to be enriched.
2. No comparison group was used to contrast data results.
3. The grade five classroom teacher is the wife of the researcher.

Assumptions

The chosen methodology of this research study, one that best suits the exploration, will follow a qualitative paradigm, "an inquiry process of understanding a social or human problem, based on building a complex, holistic picture, formed with words, reporting detailed views of informants, and conducted in a natural setting" (Creswell, 1994, p. 4).

The ontological assumption of this research study identifies the nature of reality as impartial, separate from the researcher (Firestone, 1987; Guba & Lincoln; McCraken, 1988; Creswell, 1994). An assumption in contrast to this qualitative approach is the quantitative paradigm where reality can be subjective and multiple, constructed by members participating in the research (Creswell, 1994).

The epistemological assumption of this study is that the researcher interacts with that being researched opposed to the quantitative paradigm where the researcher remains distant and independent from that being researched (Firestone, 1987; Guba & Lincoln; McCraken, 1988; Creswell, 1994).

The axiological assumption of this research acknowledges that the researcher's values will be included in the study; in contrast to the quantitative approach, where researcher's biases are removed, the qualitative approach admits and reports biases (Creswell, 1994).

Rhetoric or language used in this study will be based on the informal and personal characteristics of qualitative research (Creswell, 1994). In addition to definitions already provided, language will be based on the unfolding of commentary throughout the research study (Firestone, 1987; Guba & Lincoln; McCraken, 1988; Creswell, 1994).

The aim of this research study is to add to the collective knowledge of teacher pedagogy and student learning. This will be accomplished through exploration and descriptive processes which are best achieved through a qualitative design study.

Organization of Thesis

This thesis is organized into six chapters. The following paragraphs provide an overview of the essence of each chapter.

Chapter *One* of this thesis establishes the overview of the research study by including the introduction, purpose, main objective, significance, definitions, delimitations/limitations and assumptions of the study.

Chapter *Two* reviews literature relating to the three main strategies targeted in this study to enrich student learning of 21st century skills: one-to-one computing, instructional design and differentiated instruction. Literature reviewed provides insight into national educational technology plans, Canadian and U.S. one-to-one initiatives, learning theory and instructional design theory and instructional characteristics of differentiated instruction.

Chapter *Three* provides details on the design and methodology of the research study. This chapter describes research design, participants, data collection, methods, trustworthiness and ethics of the study.

Chapter *Four* describes the results of the research. This section provides an overview of the research procedures and further details of the interpretational and reflective analysis strategies used in the research study.

Chapter Five provides an analysis of the findings through further discussion of the results of the research.

Chapter Six consists of recommendations and implications for further research and also summarizes final conclusions from the research study.

Chapter 2: Literature Review

To better understand strategies, including one-to-one computing, instructional design and differentiated instruction, employed in the enrichment of student learning it is necessary to review literature on the need, initiatives and theories which relate to the topic. This literature review is organized to *first* examine the need for enhancing student learning by analyzing relevant reports which focus on the transformation of education. *Second*, the chapter reviews various one-to-one initiatives that either have or are being implemented within educational systems. *Thirdly*, to conclude the review, a focus on theories, including instructional design and differentiated instruction, are provided to recognize current instruction and learning strategies being used to enrich student learning.

Need to Enhance Student Learning

NETP and CEA Reports. Reports released by the U.S. Department of Education Office of Educational Technology (USDEOET) and Canadian Education Association (CEA) each state the need to transform the education system in their respective countries. The National Educational Technology Plan (NETP) titled, *Transforming American Education Learning Powered by Technology* (U.S. Department of Education, 2010) identifies that technology is at the core of people's personal and professional lives and it must be leveraged for revolutionary transformation of the education system. Comparably a CEA report titled, *What Did You Do In School Today? Transforming Classrooms Through Social, Academic and Intellectual Engagement* (Willms, Friesen, & Milton, 2009) takes the position that school transformation requires

considerable shifts in current designs of learning. "Research in the past thirty years has proven that the current model of schooling no longer adequately meets the needs of young people or of contemporary Canadian society" (Willms, Friesen, & Milton, 2009, p. 6).

In a letter to Congress, Arne Duncan (2010), the U.S. Secretary of Education identified that one directive of the NETP is for advanced technologies to be infused into the entire education system. These technologies should be used to apply real world or authentic scenarios to improve learning, increase the use of effective teaching and learning practices and use information collected from data for continuous improvement. He asserts that state-of-the-art technologies should be used with effective concepts for teaching to enable, motivate and inspire all students to accommodate continuous lifelong learning (Duncan, 2010).

Highlights of the NETP (U.S. Department of Education, 2010) include goals, recommendations and actions from a learning model based on learning sciences (e.g. cognitive science, neuroscience education, and social sciences) showing how people learn, enhanced through the power of technology. The NETP student-centred model, illustrated in Figure 3, is based on a core set of standards-based concepts and competencies. The model calls for a wider range of flexible learning resources based on Universal Design for Learning (UDL) principles and guidelines to be accessible through technology and support learning through engaging environments and resourceful tools. This includes not only content resources but other expertise available outside the

classroom walls including teachers, parents and mentors. Technology and well-designed project-based learning are to assist in the application of strategies for individualizing and differentiating instruction to meet three connected types of human learning: factual knowledge, procedural knowledge and motivational engagement.

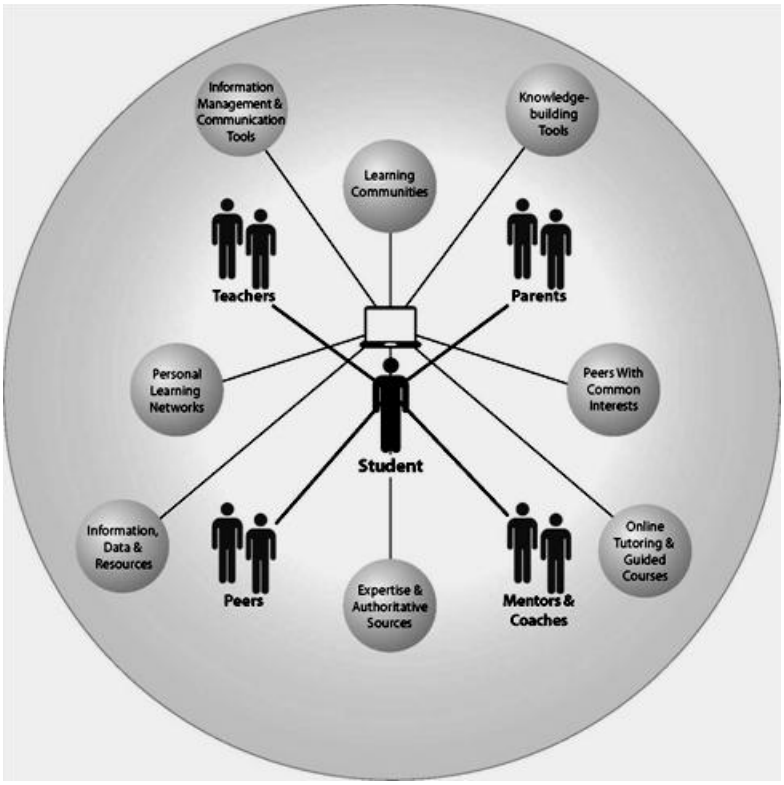

Figure 3: Model of Learning Powered by Technology (U.S. Department of Education, 2010, p. 11)

The NETP model of learning focuses on goals and recommendations in essential areas, some of which include: *learning, assessment, teaching and infrastructure*.

Learning. The NETP describes learning as a lifelong process with the understanding that members of society can no longer learn everything there is to know in a lifetime. "Learning can no longer be confined to the years we spend in school or the hours we spend in the classroom" (U.S. Department of Education, 2010, p. 9). Technology is identified as a key enabler of lifelong learning, in that it provides 24/7 access to learning. This model of student-centred learning allows flexibility for students to be empowered by taking control and personalizing their learning, compared to traditional direct teaching, 'sage on the stage' teaching strategies. "The model asks that we focus what and how we teach to match what people need to know, how they learn, where and when they will learn, and who needs to learn" (U.S. Department of Education, 2010, p. 10).

The core challenge presented in the NETP is for the education system to apply learning sciences and technology in order to provide engaging, relevant and personalized experiences which apply to learners' everyday lives and futures.

The Canadian Education Association (CEA) report titled, *What Did You Do In School Today? Transforming Classrooms Through Social, Academic and Intellectual Engagement*, by Willms, Friesen, and Milton (2009) views learning from the perspective of engaging learners. It presents findings that show levels of student engagement to be predominantly associated with policies and practices occurring in the learning environment including: "learning time, relationships, expectations for success and instructional design" (Willms, Friesen, & Milton, 2009, p. 31). Two issues arose out of

the CEA report relating to social, academic and intellectual disengagement of students in Canadian schools. The first issue is how to design instruction for students with low confidence in literacy and mathematic skills so disengagement does not occur. The second is how academically confident or successful students can be adequately challenged so disengagement does not also occur.

Willm, Friesen, & Milton (2009) found the effects of classroom and school learning climates on student engagement to be closely related. The following summarizes their key points:

- Students are more likely to be socially engaged in schools with a positive classroom and school climate. High expectations for student success appears to be the most important factor.
- Students are more likely to have positive records of attendance when classroom and school learning climates include the following: high expectations, appropriate instructional challenge.
- Students are more likely to be intellectually engaged when classroom and school learning climates reflect the following: effective use of learning time, positive teacher/student relations and disciplinary climates, high expectations for success, appropriate instructional challenge (p. 24).

The CEA report by Willms, Friesen, & Milton (2009) declares that students become engaged in their learning when participating in effective instructional challenges designed at their appropriate skill level (see Figure 4). "This relationship between skills and challenge is said to be symbiotic, where skills are neither too low, nor too high in relation to the challenge at hand" (p. 12).

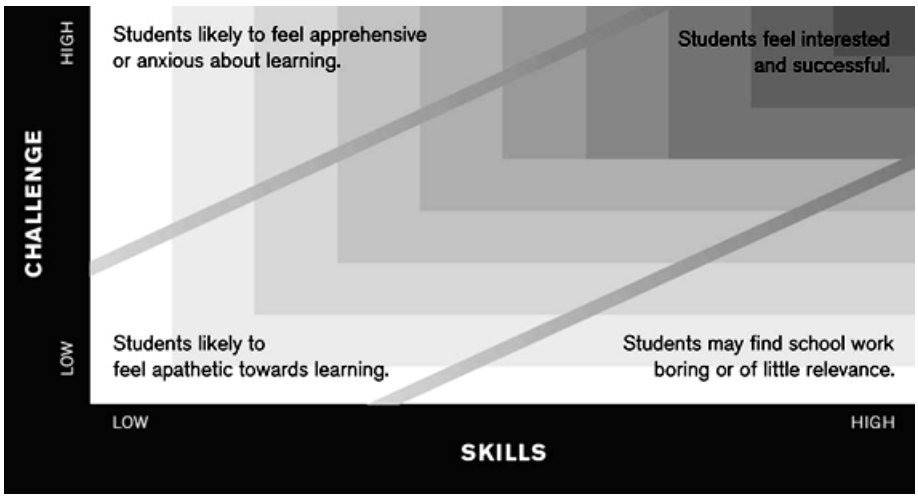

Figure 4: Instructional Challenge (Willms, Friesen, & Milton, 2009, p. 14)

Reports from government, educational and business organizations conclude that students require 21st century skills to compete in current and future job markets (Partnership for 21st Century Skills, 2004; U.S. Department of Education, 2010; Willms, Friesen, & Milton, 2009; Wilson & Peterson, 2006; 21st Century Learning Associates, 2011). Although there are conflicting descriptions and understanding of 21st century learning, the CEA report states that Canada requires engaged expert learners whose talents, skills and aspirations are nurtured throughout their entire lives (Willms, Friesen,

& Milton, 2009). These expert learners are lifelong learners who have knowledge, skills and expertise to be productive contributors to society and ultimately succeed in work and life. Skills which are fully interconnected in the process of 21st Century teaching and learning include (Figure 5): Core Subjects and 21st Century Themes, Learning and Innovation Skills, Information, Media and Technology Skills and Life and Career Skills (Partnership for 21st Century Skills, 2009).

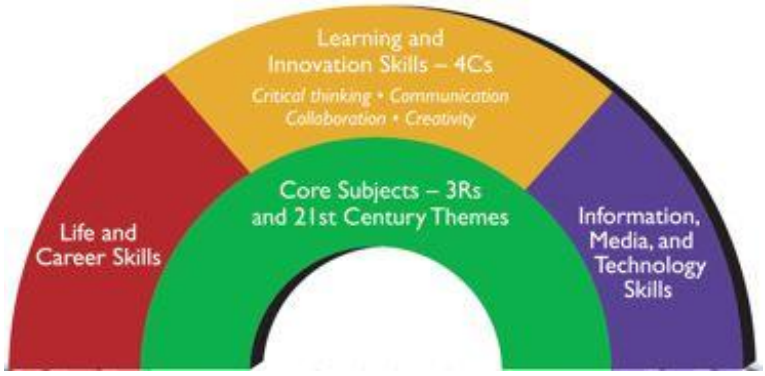

Figure 5: P21 Framework-Outcomes (Partnership for 21st Century Skills, 2004)

The NETP (2010) report states that students need to learn competencies and expertise that go beyond the traditional three Rs (R-eading, 'Riting and 'Rithmetic). Learning in the 21st century must provide students with skills encompassing critical thinking, complex problem solving, collaboration, communication, creativity, innovation and multimedia through a core set of standards-based concepts and competencies (Partnership for 21st Century Skills, 2004; U.S. Department of Education, 2010). Importantly, the NETP (2010) reports these adaptive learning skills are necessary to blend domain content knowledge with the capacity to learn new things. "This requires

developing deep understanding within specific domains and the ability to make connections that cut across domains – learning activities should replace the broad but shallow exposure to many topics that is the norm in our education system today" (U.S. Department of Education, 2010, p. 14).

Assessment. The goal for assessment, in the NETP report, is to use the power of technology in order to "measure what matters and use assessment data for continuous improvement" (U.S. Department of Education, 2010, p. 25). Traditionally student success is often gauged through external measurements that collect data on both local school and district performance (Willms, Friesen, & Milton, 2009). "To actively participate in accountable decision making, schools need access to fine-grained data that can be collected, interpreted and acted upon in local settings" (Willms, Friesen, & Milton, 2009, p. 9)

Assessments designed to measure complex skills and competencies can be achieved through technology-based learning incorporating problem-solving, multimedia, interactivity and connectivity. "Technology allows representation of domains, systems, models, and data and their manipulation in ways that previously were not possible" (U.S. Department of Education, 2010, p. 27). Technology, through the use of comprehensive assessment products like StudentsAchieve™, allows for data collection, analysis and reporting to determine what students have learned for both reporting purposes (summative) and for diagnostic and modification purposes (formative). Technology-

based learning allows for tools to be incorporated which capture student responses which can then be used to diagnose and modify student learning.

New constructivist learning models provide learners with choices as to how they learn by supporting construction of knowledge, building meaningful context for learning and allowing for collaboration among learners and teacher (Jonassen, 1994). New models of learning, including the 21st Century Learning Model (Partnership for 21st Century Skills, 2004) and the Model of Learning Powered by Technology (U.S. Department of Education, 2010) require new roles for assessment to diagnose and effectively support individual learners. The NETP (2010) suggests that technology can support better assessment using adaptive assessment to differentiate learning by applying Universal Design of Learning (UDL) principles and assistive technology to improve access to assessment for diverse needs. This would allow for quicker development and testing times for assessments, enable broader involvement in providing feedback and reduce external assessments for accountability purposes. In the end, data collected through technology-based assessment can be used to drive continuous improvement. "Once we have assessments in place that assess the full range of expertise and competencies reflected in standards, we could collect student learning data and use the data to continually improve learning outcomes and productivity" (U.S. Department of Education, 2010, p. 34).

Teaching. The NETP (2010) reports that effective teaching calls for educators to be prepared and connected. The goal is established that "professional educators will be supported, individually and in teams, by technology that connects them to data, content, resources, expertise, and learning experiences that can empower and inspire them to provide more effective teaching for all learners" (U.S. Department of Education, 2010, p. 39). The report identifies that this will be accomplished through 'connected teaching' where educators are provided 24 hour access to student analytical tools and learning data, content, resources and systems to transform learning, both in and outside of schools.

In the CEA report (Willms, Friesen, & Milton, 2009), a key to transforming schools is engaging teachers in the school improvement process. Through collaborative knowledge building processes, teachers can work collectively to understand and design effective learning experiences for students which relate directly to learning outcomes (Willms, Friesen, & Milton, 2009).

A framework is suggested in the CEA report (Willms, Friesen, & Milton, 2009) regarding classroom practices which make a difference in student engagement. This framework is based on the concept that students "might understand deeply; gain critical perspective; create professional quality work by thinking and acting with the core ideas that are unique to particular disciplines; and make positive connections with their teachers, their peers and their communities – locally, provincially, nationally and globally – through the work they do together" (Willms, Friesen, & Milton, 2009, p. 33).

The *first* feature of the CEA framework is to intentionally design instruction. "Effective teaching practice begins with thoughtful, intentional designs for learning-designs that deepen understanding and open the discipline to genuine inquiry" (Willms, Friesen, & Milton, 2009, p. 33).

The *second* feature of the CEA framework is to make student work 'mean something.' Student work needs to be worthy of their time and effort. This is accomplished by making student activities that are relevant, meaningful and authentic (Willms, Friesen, & Milton, 2009). Characteristics of effective learning tasks which are thoughtfully designed include:

- The tasks require and instill deep thinking.
- They immerse the student in disciplinary inquiry.
- They are connected to the world outside the classroom.
- They have intellectual rigor.
- They involve substantive conversation (p. 34).

The *third* feature of the CEA framework, influencing effective classroom practice is to use assessment to improve learning and guide teaching. Research has led teachers to design assessment into lessons which help students to better understand and think deeper about their own learning. "They use the assessment process to help students collect their thoughts, articulate what they have found, and speculate about where they are and where

they might go – equipping their students to become more self-directed in their learning" (p. 35).

The *fourth* feature of the framework regarding effective teaching practice is to build relationships. One of the main factors in building an environment with trust, respect and positive relationships is to maintain a positive disciplinary climate. "Students who describe their classroom disciplinary climate as positive are one-and-a half times more likely to report high levels of interest, motivation, and enjoyment in learning" (p. 35).

The *fifth* and final feature of the CEA framework on effective teaching is to improve teaching practices in the company of peers. "Research is clear that teachers improve their practice, and hence their effectiveness, when they have opportunities to practice – and become practiced – in the company of their peers" (p. 37). Described in the NETP (2010), 'connected teaching' also embodies teacher Professional Development (PD), personal learning networks (PLN), communities of practice, and online learning communities to collaborate, support, and improve instructional practice through continuous and relevant technology-based professional learning opportunities. "Online learning communities break through educators' traditional isolation, enabling them to collaborate with their peers and leverage world-class experts to improve student learning" (U.S. Department of Education, 2010, p. 42). Connected teaching is described as an approach to providing inequitable schools with access to effective educators and courses in which they may not ordinarily be able to offer. This is available through the use of

technology-based learning practices and tools including online learning (asynchronous, synchronous and blended), learning management systems (LMS), web-based communication and collaboration tools and many other web-based resources currently available.

A number of reports suggest that teachers' abilities to provide students with 21st century skills need to be improved (Bebell, Russell, & O'Dwer, 2004; Kershaw & Kershaw, 2010; U.S. Department of Education, 2010; Willms, Friesen, & Milton, 2009). The NETP (2010) affirms these skills are to begin at all institutions training pre-service teachers. "All institutions involved in preparing educators should provide technology-supported learning experiences that promote and enable the use of technology to improve learning, assessment, and instructional practices" (U.S. Department of Education, 2010, p. 44).

Infrastructure. The goal for the NETP (2010) infrastructure is to provide access to technology-based tools and resources and enable students and teachers to be able to make use of the technology-based tools and resources. "All students and educators will have access to a comprehensive infrastructure for learning when and where they need it" (U.S. Department of Education, 2010, p. 51). The report states that the infrastructure is important for connecting teachers, students, experts, parents and other individuals to create and support educational learning experiences. Infrastructure not only includes technical items related to computers, servers, broadband, wireless access, LMS, and

software, but also people, methods, resources, supports and policies related to integrate technology-based curriculum, instruction and assessment.

The CEA report (Willms, Friesen, & Milton, 2009) indicates a need to address the diverse student use of communication technologies both in and out of school. There appears to be a contrast between what communication technologies are being used outside of school and what is authorized to use in school. Stated is "the need to equip all young people for success in a period of massive, rapid and unpredictable social, technological and economic change" (Willms, Friesen, & Milton, 2009, p. 6).

The NETP (2010) suggests that 24/7 unlimited access through both personal and institutional devices should be granted on educational infrastructure. As educational institutions face challenges in providing access devices for each student, the NETP (2010) recommends new creative solutions to this dilemma including: allowing student use of personal digital devices and solving equity issues by purchasing devices for students who do not have financial means to obtain devices. "Districts can think about providing an access device and Internet access at home for those students who need them in the same way they provide a free or reduced-price hot lunch for students who could not otherwise afford it" (U.S. Department of Education, 2010, p. 55).

One-to-One Computing

Research identifies that there is rapid growth in K-12 ubiquitous computing initiatives throughout Canada, United States and globally (Warschauer, 2006; Bianchi,

2004; Silvernail & Lane, 2004; Penuel, 2006). A 2010 gathering in Vienna, Austria brought together project administrators from 17 countries, including Canada and the United States, to share information, insights and experiences from what is believed to be the first global gathering of representatives from prominent one-to-one computing initiatives (Trucano, 2010). Innovators at the forefront of one-to-one initiatives become invaluable resources through shared experiences to build capacity around ubiquitous computing. To gain perspective and understand one-to-one computing initiatives, this section of the literature review synthesizes research findings from a variety of one-to-one computing initiatives throughout North America including: State of Maine, Quebec, Texas, New Brunswick and Lake Tahoe.

Research Synthesis. A research synthesis titled *Research: What It Says About 1 to 1 Leaning* (Penuel, 2005) sponsored by Apple Computers, Inc., analyzed key research-based findings from thirty separate research studies conducted between 2001 and 2005. The report identifies the cause for global increase of one-to-one initiatives associated with the decreasing costs of laptops, wireless connectivity and infrastructure. The key findings of this report, reviewed below, are organized into sections including: goal and scale, computer usage, successful implementation, effects of one-to-one initiatives, and, research.

Goal & Scale. Goals of the thirty one-to-one initiatives, reported on by Penuel (2005), center around four common themes. The first is improving academic achievement through the use of technology. A second theme is to increase accessibility

to digital tools, reducing the digital divide amongst students. The third common theme is to increase the economic competitiveness for students to be able to compete for jobs in "today's technology-saturated workplaces" (Penuel, 2005, p. 3). The fourth common theme is to transform quality of instruction to incorporate more student-centred, differentiated and problem-solving approaches to allow for higher-order thinking skills.

The scale, including funding dollars, resources and supports, to which ubiquitous initiatives are rolled out varies a great deal. One can find examples ranging from modest pilot projects, experimenting classroom by classroom, to larger initiatives comprising of entire school divisions or districts and even complete provinces or states.

Computer Usage. The use of the laptops in the research synthesis by Penuel (2005) demonstrate that students were writing, taking notes, completing homework assignments, organizing, communicating and researching with the devices. The laptop usage revealed that teachers were in an 'adaption' stage of technology integration (Penuel, 2005). This is one of the five stages of professional development (Figure 6) teachers pass through when integrating technologies into educational environments (Dwyer, 1995).

Stage	Examples of what teachers do
Entry	*Learn the basics of using the new technology.*
Adoption	*Use new technology to support traditional instruction.*
Adaptation	*Integrate new technology into traditional classroom practice. Here, they often focus on increased student productivity and engagement by using word processors, spreadsheets, and graphics tools.*
Appropriation	*Focus on cooperative, project-based, and interdisciplinary work incorporating the technology as needed and as one of many tools.*
Invention	*Discover new uses for technology tools, for example, developing spreadsheet macros for teaching algebra or designing projects that combine multiple technologies.*

Figure 6: Teacher Development Stages of Technology Incorporation (Penuel, 2005, p. 16)

Successful Implementation. Items leading to successful implementation of one-to-one initiatives in the Penuel (2005) report include infrastructure, support and teacher beliefs.

Infrastructure, including working laptops and reliable wireless networks, is identified as one of the starting points necessary for successful implementation of one-to-one initiatives. Throughout earlier stages of classroom technology integration, a focus was to have computer labs set up in schools. Expert leaders are now changing this perspective from what they are learning from one-to-one initiatives. The authors of Generative Leadership believe, "If we had been careful watchers of technology trends a decade ago, there would be fewer schools with computer labs and more with the bandwidth and infrastructure to accommodate full-scale one-to-one programs (Klimek, Ritzenhein, & Sullivan, 2008).

Support systems for one-to-one initiatives include formal professional development (PD), colleagues and even students (Penuel, 2005). Workshops are recognized as critical PD for providing teachers with skills to learn and integrate technology into instruction. PD focusing on helping teachers become more 'student-centred' has been effective in transforming instruction for one-to-one environments. An example of this is the iNtegrating Technology for inQuiry (NTeQ) model which "provides a framework for creating an environment for students to use computers as tools to build strong educational background while solving meaniningful problems" (Lowther & Morrison, 1998, p. 33).

Formal and informal support from colleagues is helpful for successful implementation of one-to-one initiatives. Colleagues can fill a role of content specialist to help with technology integration and developing or finding digital resources (Penuel, 2005).

Students are also identified as part of the support plan for one-to-one initiatives. In many of the one-to-one initiatives, students go through basic computer technical training to provide a first line of technical support as part of the program design (Penuel, 2005). Students interested, receive basic information computer technology (ICT) training for problem solving computer issues. As a result of the training the students are often capable to assist with basic computer or IT issues when they occur in the one-to-one computing environment. This relieves the pressure and time constraints on the organizations IT staff for issues that can easily be solved with basic computer training.

The research synthesis by Penuel (2005) identifies that teacher attitudes and beliefs are able to influence the implementation and success of one-to-one initiatives. Teacher case studies reveal that degrees to which students are allowed to use laptops are influenced by teacher's beliefs and attitudes toward their students, technology and access to high-quality digital content.

Effects of One-to-One Initiatives. Earlier one-to-one computing reviews such as one conducted by Stanford Research Institute (SRI) International, an independent, nonprofit research institute conclude that there is not enough research-based evidence to determine the effectiveness of one-to-one initiatives due to the weak design of the research studies (Penuel, 2005). However, more recent research-based studies on the effects of one-to-one computing are producing some positive results. A research study conducted by Russel, Bebell and Higgins (2004) compared computer to student ratios of 4:1, 2:1 or 1:1 in upper elementary classrooms. Results in this study confirmed that one-to-one classroom teachers delivered instruction more often to smaller groups, students used computers more regularly, more across the curriculum and more at home for academics. Also, there is evidence from a German research study revealing that students participating in a one-to-one inititive showed an increase in computer literacy, particularly in hardware, software and Internet knowledge (Schaumburg, 2001). Finally, in his synthesis report of one-to-one initiatives, Penuel acknowledges that "available research-based evidence is generally positive, especially with respect to laptop

programs'effects on technology use, technology proficiency, and writing skills" (2005, p. 13).

A research team from the University of California-Irvine investigated one-to-one initiatives from seven schools in California and three in Maine. A report of the research findings provides both what to expect and not to expect out of one-to-one initiatives. One-to-one initiatives are not likely to achieve higher test scores, reform for troubled schools or provide a solution to the digital divide (Warschauer, 2006). However, what could be expected out of one-to-one initiatives include: facilitation of 21st century learning skills, greater engagement through multimedia, more and better writing, deeper learning, and easier integration of technology into instruction. The researcher of this thesis finds it somewhat difficult to believe that higher test scores are not achieved with such expecations from a one-to-one computing initiative.

Research. Penuel (2005) affirms the challenges to conducting rigorous research on one-to-one initiatives, "Overall, however, there is limited research-based evidence from rigorously designed experimental or quasi-experimental studies of laptop programs' effectiveness" (p. 13). It is believed that before further investments are made on one-to-one initiatives, additional research including quasi-experimental and experimental research focusing on outcomes and implementation is required.

One-to-One Examples.

State of Maine. One of the largest, high-profile one-to-one initiatives was the Maine Learning and Technology Initiative (MLTI). The initiative provided laptop

computers first in 2003 to middle school students, and later in 2009, to high school students throughout the entire state of Maine (Silvernail, 2009). MLTI, designed to provide students with 21st century skills, cost nearly 120 million dollars to implement (Wintle & Silvernail, 2010; Weston & Bain, 2010).

The MLTI found leadership to be a critial charateristic necessary for successfully implementing one-to-one initiatives. Leadership teams, including a principal, teacher leader and technology lead person for every school, are part of the MLTI one-to-one implementation plan (Wilson, 2009).

Chris Toy (2008), a principal from Freeport Middle School (FMS), one of the schools participating in MLTI, considers ten lessons learned for administrators when implementing one-to-one learning. Principals must:

- Model the use of the same technology they expect teachers to use.
- Be consistent in supporting the decision to implement one-to-one technology in the school.
- Communicate expectations clearly.
- Provide appropriate professional development, time, and resources to support effective implementation.
- Support early adopters and risk takers.
- Ensure that everyone working with students who have laptops also have laptops.

- Mediate technical issues that threaten to compromise access for learning with access to the technology.
- Support the expectation that students and teacher work will be done and stored using technology.
- Ensure that families and the public are kept informed about the project.
- Be active and public champions for students, staff, their school, and for the program (pp. 3-6).

Effective leadership for MLTI success is described by Silvernail (2009), Director of Research for the Maine International Center for Digital Learning at the University of Maine, to include:

- There must be a clear strategic vision and plan.
- Teachers must receive strong, meaningful and sustained professional developments and support.
- Technology use must be appropriate to the task and focused.
- The technology use must be used as a learning tool.
- Assessments must match learning with technology.
- There needs to be clear evaluation and research plans developed early in the initiative.
- It is important to articulate and manage expectations (p. 8).

Quebec. The Eastern Township School Board (ETSB) in Quebec began the three year Enhanced Learning Strategy (ELS) in 2003, with the first deployment of 1,630 wireless iBook computers to grades five and six students (Easter Townships School Board, 2003). In the third year of the program all ETSB students from third grade to fifth level of high school were provided a portable computer to use during the school year (Easter Townships School Board, 2003). Ron Canuel (2009) the Director General of ETSB, communicates the ELS one-to-one initiative provided all teachers and 5600 students with free Apple wireless laptops since the start of the project. In 2003, "The Dennis McCullough Initiative-Enhanced Learning Strategy was identified as the only systemic deployment of a one-to-one laptop program from grades three through to adult education in the country" (Eastern Townships School Board, 2006). Primary objectives of ELS were to enhance students' achievements through improving: (1) Integration of 21st century skills (2) literacy (3) numeracy (4) reduction in the student retention (5) reduction in the dropout rates (6) increase in graduation rates (Eastern Township School Board, 2010).

A research study summarizing main results of the benefits and challenges of using laptops in primary and secondary schools in the Eastern Townships School Board was conducted by Karsenti and Collins (2011). The research study attempted to seek a deeper understanding of the role of the laptops in examination improvements and in advancing the school board from 66th position in the province (out of 70) in 2003 to 23rd in 2010.

Challenges of the laptops were identified as technical and pedagogical. Technical challenges included computer breakdowns and malfunctions. Proper funding policies were necessary to provide sustainable funding for project success and positive teacher and learning outcomes. Pedagogical challenges included some information and computer technology (ICT) activities that were not appealing or stimulating for students. As a result students used the laptops for fun instead of learning, allowing ICT to be a source of distraction rather than supporting learning. Teacher issues, with the use of laptops were related to challenges of pedagogical integration of ICT. Teachers felt their training had little impact on pedagogical use of ICT in the classroom. "Consequently, the professional development of teachers in the pedagogical integration of ICT seemed to be largely trial and error" (Karsenti & Collins, 2011, p. 12)

The research by Karsenti and Collins (2011) on the Enhanced Learning Strategy (ELS), presented 12 main benefits of using laptops in the classroom. The 12 main benefits were identified by the majority of the students and teachers to include:

- Facilitation of schoolwork for students and teachers, and consequently time saving;
- Increased access to current, high-quality information;
- Greater student motivation;
- Improved student attentiveness;
- Development of student autonomy

- Increased interaction between students and between students and their teachers;
- Individualized, differentiated learning;
- Active, interactive and meaningful learning with multimedia support;
- Development of ICT skills;
- Universal access;
- Breakdown of the barriers between school and society;
- More opportunities for the future (p. 13).

Texas. The Texas legislature implemented a technology immersion project for high-need middle schools in 2003 titled, Technology Immersion Pilot (TIP) (Shapley, Sheehan, Maloney, & Caranikas-Walker, 2008). The four-year pilot project compares immersion classrooms with controlled classrooms in 22 schools (Weston & Bain, 2010). This 14.5 million dollar pilot project provided wireless mobile computing devices to each student and teacher, digital learning resources, PD for teachers and support in authentic use of technology (Shapley, Sheehan, Maloney, & Caranikas-Walker, 2008)**.**

Results on effective leadership within the Texas TIP claim to have allowed for innovation, promote parent and community involvement, ensure PD and provide efficient technical support (Wilson, 2009). The TIP initiative identified that full implemenation is achieved when school leaders, teachers, IT, parents and community support the project (Wilson, 2009).

New Brunswick. A project final report by Fox, Greenlaw and MacPherson (2006) provides research findings on a 2004 New Brunswick program titled the *1:1 Dedicated Student Notebook Research Project*. "The goal of the research investigation was to determine how providing New Brunswick students and teachers with their own portable notebook computers affects the learning experience and instructional approaches in their classrooms" (p. 6). The Government of New Brunswick launched the one-to-one initiative through two phases, incorporating grade 7-9 level students in six research schools (three anglophone schools and three francophone schools). Phase I of the initiative began in the fall of 2004, providing teachers with notebook computers, professional development, and a support team, including a pedagogical teacher-mentor and technical support person in each of the six schools. The comprehensive technological and pedagogical support plan, provided by the New Brunswick Department of Education, resulted from consultation with the research team, select school divisions across North America, technical suppliers, and the Canada Research Council. In January 2005, 237 grade seven students received notebook computers marking the end of phase I. Phase II began in September 2005 issuing a new group of 262 grade seven students notebook computers. The previous groups of grade seven students, now in grade eight, were able to keep their notebook computers as they advanced to the next grade level.

As a consequence of positive results from interim reports of the initial Dedicated Notebook Research Project, the New Brunswick Department of Education announced in March 2006, an implementation plan for a comparable initiative titled the *Notebook*

Initiative. The Notebook Initiative provided notebook computers to an additional 1000 New Brunswick students in between Phase One and Phase Two of the initial research project. See Appendix H for The Notebook implementation plan (Fox, Greenlaw, & MacPherson, 2006).

John D. Kershaw, the New Brunswick Deputy Minister of Education at the time, announced even further expansion of one-to-one initiatives. In 2008-09 the New Brunswick one-to-one initiative expanded to include 24 schools encompassing 3900 students (Kershaw & Kershaw, 2010). Two further agreements have since been announced by Kershaw (2010) relating to New Brunswick's 21st century learning agenda. A 2010 agreement between the New Brunswick Department of Education and three New Brunswick Universities Faculties of Education set to embrace new 21st Century standards for beginning teacher training. Within three years, 21st Century standards are to encompass reformed pedagogy accommodating information and communications technology (ICT) and a one-to-one computer integration model for university students. This agreement supports the goal for the New Brunswick Government to provide one-to-one computing initiatives to upper grade levels in the near future. A second, 2010 agreement with the National Research Council (NRC) of Canada's Institute for Information Technology formed a partnership to develop a 21st Century Learning Technology Centre at the NRC facility on the University of New Brunswick campus in Fredericton, NB. One of the directives for the centre is to design and develop

technologies, programs and content to support 21st century learning initiatives to New Brunswick schools.

Lake Tahoe, CA. The Lake Tahoe Unified School District (LTUSD) in California began a pilot project in 2010 providing every student from the third to twelfth grade with a small computer called a netbook. LTUSD is the only district in the State piloting a one-to-one initiative which initially cost the school district $160,000 (Keegan, 2010). The LTUSD netbook program authorizes students to sign out their netbooks from the library and take the netbooks home after school. When away from school, the netbooks connect to the Internet through local hotspots available throughout the community. This provides wireless Internet access without having high speed Internet at home. LTUSD blocks all websites allowing only school district approved websites to be accessible on the netbooks. Students use web 2.0 apps to create documents which are saved and accessed through cloud computing.

Instructional Design

To understand instructional-design theory, it is helpful to distinguish what it is *not*. Although instructional-design theory has historical roots with and is closely related to learning theory, these two theories differ in important aspects (Reigeluth, 1999). Learning theories are descriptive in nature; they focus on portraying how learning occurs. Instructional-design theory contrasts learning theory in that it "describes specific events outside of the learner that facilitate learning (e.g., methods of instruction), rather than

describing what goes on inside a learner's head when learning occurs" (Reigeluth, 1999, p. 13). So, instructional design theory is closely linked to learning theory by the fact that good instructional designers implement theories of learning when selecting appropriate methods or inventing new methods of instruction (Winn, 1997; Smith & Tillman, 2005). Ertmer and Newby (1993) provide four reasons why this emphasis on learning theory is important:

1. First, learning theories are a source of verified instructional strategies, tactics, and techniques.
2. Second, learning theories provide the foundation for intelligent and reasoned strategy selection.
3. Third, integration of the selected strategy within the instructional context is of critical importance.
4. Finally, the ultimate role of a theory is to allow for reliable prediction (Richey, 1986).

Three learning theories used as the foundation of instructional-design include behaviorism, cognitivism and constructivism. Instructional design uses these three learning approaches to construct learning resources that are most effective to the context of the learner (Ertmer & Newby, 1993). This literature review will now examine the main features in each of the three learning theories.

Behaviorism is a conceptual, theoretical framework based on behavioral changes through repeated behavioral patterns until the behavior becomes automatic (Schuman & Ritchie, 1996). The main principle in which behaviorism functions is "stimulus/response" (Learning Theories, 2008). Behavior is caused by external stimuli and is not conditioned upon internal mental states or consciousness (Learning Theories, 2008). The educational philosophy of behaviorists is identified as extreme empiricism (objectivism) where knowledge is acquired only through experience (Smith & Tillman, 2005). Some of the prominent theorists of behaviorism include: John B. Watson, Ivan Pavlov, B.F. Skinner, E.L. Thorndike (connectionism), Bandura and Tolman (moving toward cognitivism) (Learning Theories, 2008).

Cognitivism, which replaced behaviorism as the dominant educational learning theory in the 1960s, is based on the thought process behind a behavior (Schuman & Ritchie, 1996). The cognitivist learning theory is informed by a rationalist philosophy where the primary source of knowledge is reason, and reality is constructed, not discovered (Smith & Tillman, 2005). In the cognitivist view, the focus should be on understanding the "black box" of the mind (Learning Theories, 2008). Behavior changes are observable but represent what is occurring in the mind of the learner (Schuman & Ritchie, 1996). Prominent theorists of cognitivism include: Merrill (Component Display Theory), Reigeluth (Elaboration Theory), Gagne, Briggs, Wager, Bruner (moving toward cognitive constructivism), Schank (scripts), Scandura (structural learning) (Learning Theories, 2008).

Constructivism is based on the idea that learning is an active, constructive process in which we individually establish our perspective of the world based on schema and personal experiences (Schuman & Ritchie, 1996). Learners are information constructors who actively construct personal subjective representations of objective reality (Learning Theories, 2008). Similar to cognitivism, the educational philosophy of constructivism is a rationalist philosophy (Smith & Tillman, 2005). A focus for constructivism is to provide learners with problem solving abilities when faced with ambiguous learning scenarios (Schuman & Ritchie, 1996). Prominent theorists of constructivism include: Vygotsky, Piaget, Dewey, Vico, Rorty, and Bruner.

Driscoll (2005) describes that learning problems can be analyzed from two perspectives, one being the learner perspective and other as the teacher or instructor perspective. To design effective instruction, she suggests focusing on the learning problem from the standpoint of the teacher or instructor. When instruction is designed from this perspective, the foundation can be structured around theories of instruction rather than theories of learning.

Reigeluth (1999) believes instructional design theory to be a theory focused on helping people to learn and develop through explicit guidance. Common characteristics of all instructional-design theories are described by Reigeluth (1999) to include:

> *First*, unlike more familiar kinds of theories, instructional-design is design-orientated (focusing on means to attain given goals for learning or development),

> rather than description orientated (focusing on the results of given events). … Being design orientated makes a theory more directly useful to educators, because it provides direct guidance on how to achieve their goals.
>
> *Second*, instructional-design theory identifies methods of instruction (ways to support and facilitate learning) and the situations in which those methods should and should not be used.
>
> *Third*, in all instructional-design theories, the methods of instruction can be broken into more detailed component methods, which provide more guidance to educators.
>
> And *fourth*, the methods are probabilistic rather than deterministic, which means they increase the chances of attaining the goals rather than ensuring attainment of the goals (p. 6).

In a report titled, *First Principles of Instruction*, Merril (2002) identifies five prescriptive principles which are common in a variety of representative instructional-design theories. Principles of instruction are defined to be a relationship that is always consistent under appropriate circumstances and unconditional to the activity or approach used. Principles of instruction are described to consist of the following properties:

> First, learning from a given program will be promoted in direct proportion to its implementation of first principles. Second, first principles of instruction can be

implemented in any delivery system or using any instructional architecture.

Third, first principles of instruction are design oriented or descriptive. They relate to creating learning environments and products rather than describing how learners acquire knowledge and skill from these environments or products (p. 44).

In his report, Merrill (2002) claims that common principles can be found in countless instructional design theories. He believes that authors of these representative theories would be in agreement regarding the common principles being essential for designing effective and efficient instruction. Representative theories examined in his report include: Star Legacy by Vanderbilt Learning Technology Center, 4-Mat by McCarthy, instructional episodes by Andre, multiple approaches to understanding by Gardner, collaborative problem solving by Nelson, constructivist learning environments by Jonassen and learning by doing by Schank.

After reviewing these instructional theories, Merrill (2002) suggested five principles that appeared to be consistent throughout the theories and congruent with his phases for effective instruction. The five principles are presented below, followed by Figure 7 illustrating phases for effective instruction.

Learning is promoted when:

1. Learners are engaged in solving real-world problems.
2. Existing knowledge is activated as a foundation for new knowledge.
3. New knowledge is demonstrated to the learner.

4. New knowledge is applied by the learner.
5. New knowledge is integrated into the learner's world.

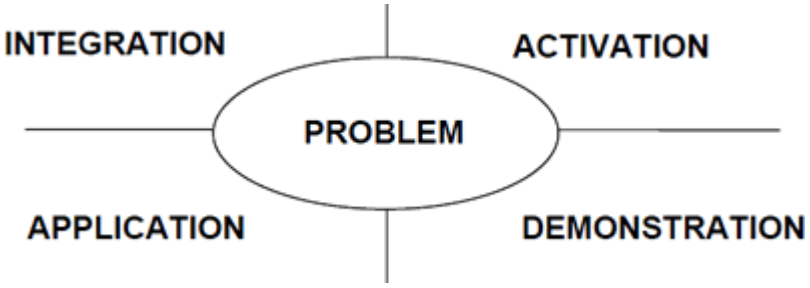

Figure 7: Phases for Effective Instruction (Merrill, 2002, p. 45).

Differentiated Instruction:

Differentiated instruction (DI) is a broad term referring to a cluster of educational theories and practices. One of the leading researchers, Tomlinson (2001), describes DI as a teaching theory focusing on diverse instructional approaches, adapted to address the range of individual needs and contrasting abilities of learners in a classroom. The DI approach calls for teachers to strategically plan curriculum which is flexible and responsive in presenting multiple approaches to provide information to learners of differing abilities within the same learning environment (Benjamin, 2005; Tomlinson, 2001). DI, therefore, is a result of intentional planning of items including curriculum, instruction, and learning environment, to make them suitable and significant for each learner (McQuarrie, McRae, & Stack-Cutler, 2008).

The founding pedagogical theory guiding DI is constructivism (Benjamin, 2005). Through the constructivist approach, DI combines what is understood about learning theory, learning styles, and brain development with practical research on influential components of learner readiness, interest and intelligence preferences regarding learners' motivation, engagement and academic improvement (Tomlinson & Allan, 2000). Figure 8 presents a flow chart illustrating steps that can be followed to differentiate instruction for individual learners.

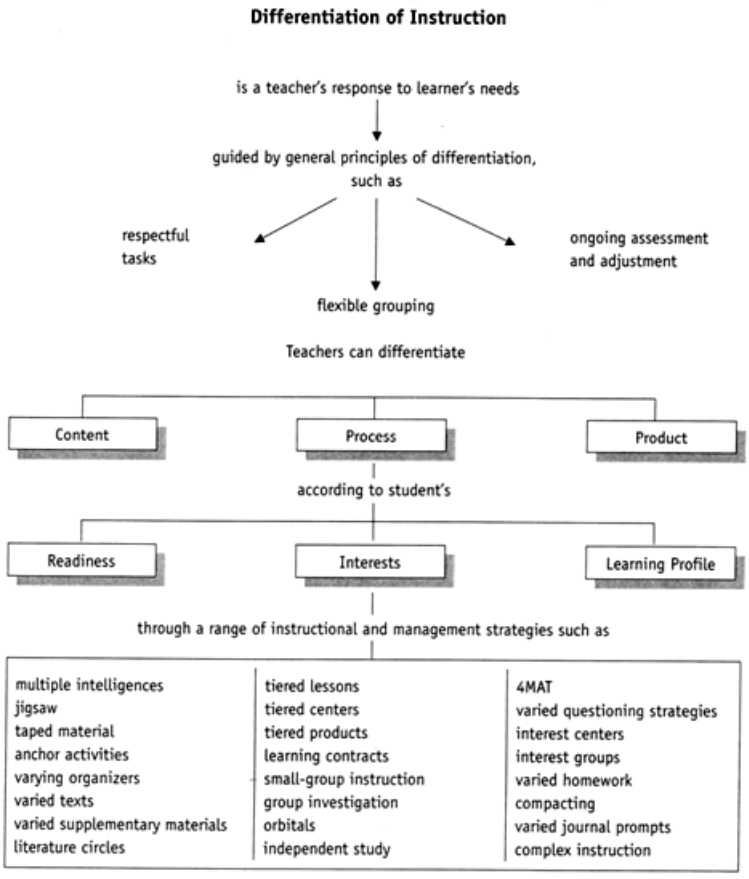

Figure 8: Differentiation of Instruction (Tomlinson, 1999, p. 15)

Differentiated Instruction (DI) suggests being a more manageable approach to teaching and learning due to the fact that the teacher does not individualize instruction for each and every student (Good, 2006). DI consistently aligns tasks and objectives to learning goals for the entire class. "In a differentiated classroom, the teacher proactively plans and carries out varied approaches to content, process, and product in anticipation of and response to student differences in readiness, interest, and learning needs" (Tomlinson, 2001, p. 7).

Curriculum and Instruction are the Vehicle. In the book Fulfilling the Promise of the Differentiated Classroom (2003), Tomlinson identifies three interrelated and interdependent cogs of differentiation. Each of the three DI cogs (shown in Figure 9) characterizes the breakdown of components which produce effective learning environments for students: the student seeks, the teacher responds and curriculum & instruction are the vehicle.

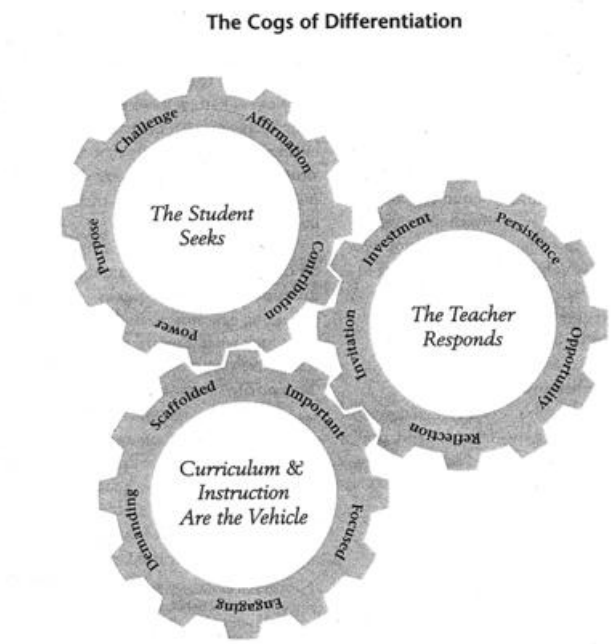

Figure 9: The Cogs of Differentiation (Tomlinson, 2003, p. 11)

It is understood that each of the cogs are interrelated and interdependent, however, for the purpose of this research study, the focus will be on the third cog, of "Curriculum and Instruction Are the Vehicle." It is necessary for this research study to centre on this cog as it pinpoints elements of curriculum and instruction that are important when designing for 21st Century teaching and learning. This cog is separated into five characteristics of effective curriculum and instruction including: curriculum that is important, curriculum and instruction that are focused, curriculum and instruction that are engaging, curriculum and instruction that are demanding and curriculum and instruction that are scaffolded (Tomlinson, 2003). A further examination of each of the five characteristics is provided below.

Important Curriculum and Instruction. Tomlinson (2003) states that curriculum which is important implies that quantity of information does not overshadow depth of understanding and richness of content. There should be a clear understanding as to why we are using specific curriculum content. Five common core criteria provided by Nelson (2001) describe what curriculum should achieve:

> *Utility* – Will the knowledge or skill significantly enhance long-term employment or educational prospects and personal decision making?
>
> *Social responsibility* – Will the content help citizens participate intelligently in making social and political decisions?
>
> *Intrinsic value of the knowledge* – Does the content have pervasive cultural or historical significance?
>
> *Philosophical value* – Does the content help individuals ponder the enduring questions of what it means to be human?
>
> *Childhood enrichment* – Will the content enhance the unique experiences and values of childhood? (p. 13).

Focused Curriculum and Instruction. In the second characteristic, Tomlinson (2003) writes that curriculum and instruction that are focused, establish a teaching and learning environment constructed around learning goals that allow for students to become highly competent in knowledge, understanding and skill. It is mentioned that focused

curriculum first provides students with what they need to know, understand, and be able to do as a result of the curriculum. The next step towards a focused curriculum is to pre-assess students. This helps to establish student individual and group strengths and weaknesses in order to direct each student toward knowledge, understanding and skill development based on learning goals. The final step to focused curriculum, as described by Tomlinson (2003), is to produce or demonstrate something to represent their knowledge, understanding and skill of the learning outcome. The overall purpose of focused curriculum and instruction is to be sure that everyone in the class, including teacher and students, understand the learning goals and that work being done in the classroom is associated with learning goals.

Engaging Curriculum and Instruction. The third characteristic of effective curriculum and instruction offered by Tomlinson (2003) is curriculum and instruction that are engaging. "Much of the fine art of teaching comes in figuring out how to deliver the curricular fundamentals in ways that are irresistible to young minds" (Tomlinson, 2003, p. 62). Research has determined some conditions for motivating young learners to be: novelty, cultural significance, personal interest, personal relevance or passion, emotional connection, product focus, potential to make a contribution or link with something greater than self and choice (Tomlinson, 2003).

Implementing technology into curriculum and instruction is seen by many teachers as a way to engage students. "Most teachers are eager to embrace new technology, as they have seen their students' excitement and motivation increase when

they do so" (Pitler, Hubbell, Kuhn, & Malenoski, 2007, p. 1). Technology helps to initially capture attention and motivate students, however suggestions have been made that student engagement can be increased and maintained through well designed instruction based on student-centred authentic learning (Lombardi, 2007; Renzulli, Gentry, & Reis, 2004; Tomlinson, Brimijoin, & Narvaez, 2008; Hume, 2008). The developmental psychologist Jerome Bruner (1966) suggested that through proper instructional design, learners, even young learners, are capable of learning any material. Although advancements in technology play an important role and continue to provide innovative opportunities for teaching and learning, it must be understood, also important to the recipe is changing teacher pedagogy, motivating students, and creating authentic learning experiences (Herrington & Herrington, 2006; Pitler, Hubbell, Kuhn, & Malenoski, 2007). Educators do not need to worry about the technology ingredients, as they are already in the mix. However, they do need to worry about technology-based pedagogy, motivation, and authentic learning.

Engaging Curriculum and Instruction. The fourth characteristic described by Tomlinson (2003) relating to effective curriculum and instruction is curriculum and instruction that are demanding. She explains that students respect both classes and themselves more when they participate in learning environments which promote hard work, engagement, curiosity, perseverance, independence, openness and enjoyment. Demanding curriculum and instruction does not exclude any learner from the opportunity to participate in higher levels of complex thinking. This is accomplished by maximizing

student growth and success through analyzing where the learner currently is and providing appropriate and challenging learning options based on individual student needs (Hall, Strangman, & Meyer, 2003).

It is proposed that many features of technology-rich learning environments allow for demanding curriculum and instruction (Benjamin, 2005; Pitler, Hubbell, Kuhn, & Malenoski, 2007). An update to Bloom's Revised Taxonomy titled Bloom's Digital Taxonomy (Figure 10) by Churches (2009) illustrates how new behaviours and actions relating to technology advancements can be integrated into curriculum and instruction. Bloom's Digital Taxonomy is not restricted to the cognitive domain as in Bloom's Taxonomy and Bloom's Revised Taxonomy. The Digital Taxonomy includes cognitive elements along with methods and tools that can be used in the classroom taking into account new behaviours, actions and learning opportunities associated with 21st Century teaching and learning (Churches, 2009). Churches points out that Bloom's Digital Taxonomy "is not about the tools and technologies, these are just the medium, instead it is about using these tools to achieve: recall, understanding, application, analysis, evaluation and creativity" (2009, p. 3). The Bloom's Digital Taxonomy focuses on new media literacy of digital natives opposed to Bloom's Revised Taxonomy which relates more to methods used in a traditional classroom environment (Churches, 2009).

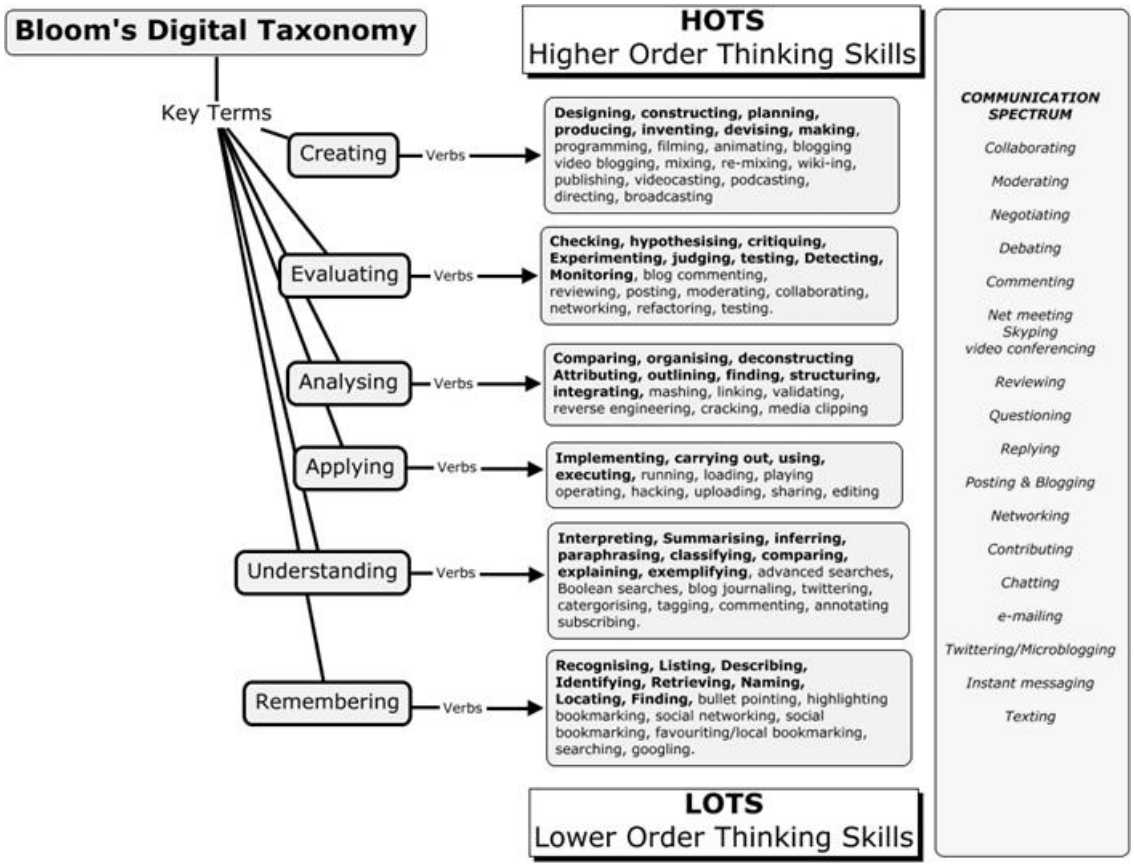

Figure 10: Bloom's Digital Taxonomy (Churches, 2009, p. 7)

Scaffolded Curriculum and Instruction. The fifth and final characteristic of effective curriculum and instruction communicated by Tomlinson (2003) is curriculum and instruction that are scaffolded. This is a result of teachers positioning student tasks just above their current ability to challenge students but yet providing support to allow for student success. Curriculum and instruction that are scaffolded are characterized to:

- Provide guidance for the teacher in teaching diverse learners successfully.

- Establish criteria for classroom operation that are clear to students and support their success.
- Include varied modes of teaching to reach varying learners.
- Utilize teacher modeling, organizers, and a variety of instructional strategies to reach varied learners.
- Use small group and whole group instruction as well as individual coaching to reach varied learners.
- Include varied materials to support growth of varying learners.
- Allow flexible use of time in response to students' varied rates of learning complex materials.
- Build in a range of peer support mechanisms to support varied learner needs.
- Provide varied avenues to learning and expressing learning to support differences among students.
- Specify criteria for quality work and coaching students in achieving those criteria.
- Involve learners in establishing personal goals and criteria for their own work and assessing their progress according to those criteria (p. 66).

Benjamin (2005) trusts that technology is one of the best ways to differentiate instruction due to the fact that it: facilitates classroom management, provides an infinite variety of resources and affords privacy. Mid-continent Research for Education and

Learning (McREL) conducted a research synthesis in 2007 which reported that technology can be used effectively with at-risk and special needs student learning for reasons including: it is nonjudgmental and motivational, facilitates frequent and immediate feedback, allows for student needs to be met through designs of individual learning, student autonomy, and provides multi-media learning environment including sound, images and text (Pitler, Hubbell, Kuhn, & Malenoski, 2007).

Research indicates that curriculum and instruction that is differentiated has many advantages, however it does not come without a cost. To design curriculum and instruction that is important, focused, engaging, demanding and scaffolded takes equipment, time, experience, collaboration and training. Content designed to meet various characteristics of DI requires intentional planning, collaboration between school professionals, mentoring and relevant professional development (McQuarrie, McRae, & Stack-Cutler, 2008). Educational environments designed to engage learners with resources accessible anytime and anywhere require state-of-the-art infrastructure, including technology and supports of people and processes (U.S. Department of Education, 2010).

Content, Process and Products. There are specific elements guiding learning cycles and decision factors when planning and implementing DI. Tomlinson (2001) identified three elements in which curriculum can be separated in order for it to be conveniently differentiated: content, process and products. Figure 11 illustrates the flow

of the learning cycle and decision factors which can be used for planning and implementation of differentiated instruction.

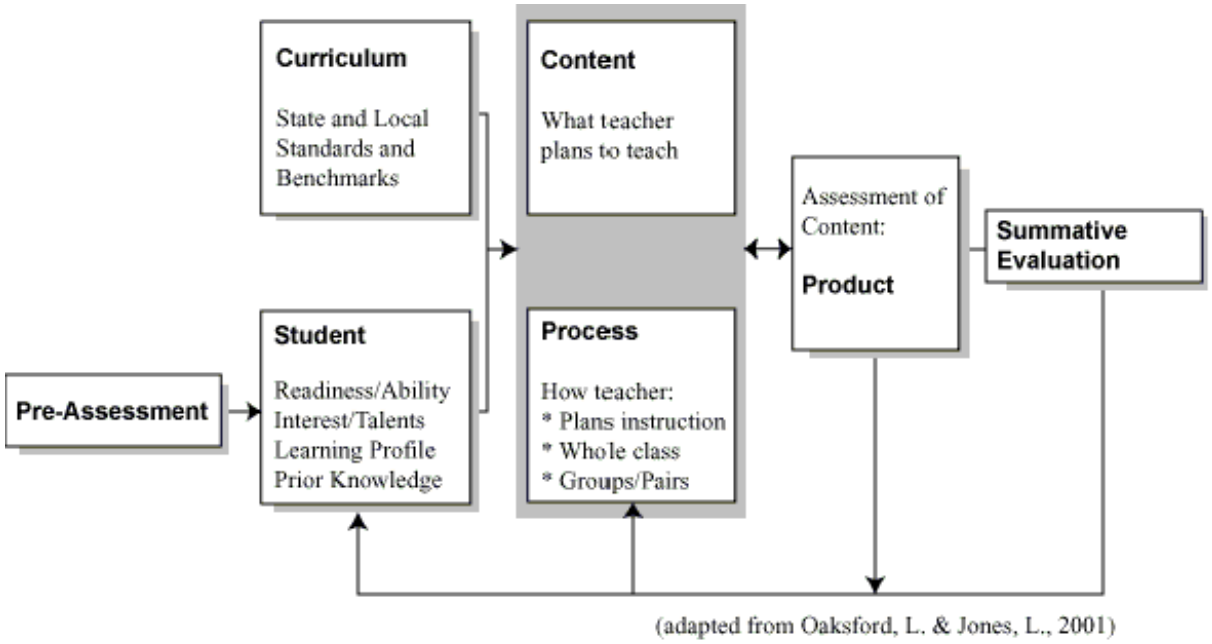

Figure 11: Learning Cycle and Decision Factors Used in Planning and Implementing Differentiated Instruction (Oaksford & Jones, 2001).

Content is described as "what we teach or what we want students to learn" (Tomlinson, 2001, p. 72). When differentiating by content, Hall (2002) identifies several guidelines to help understand and develop ideas.

> *Several elements and materials are used to support instructional content.* These include acts, concepts, generalizations or principles, attitudes, and skill. The variation seen in differentiated classroom is most frequently the manner in which students gain access to important learning. Access to the content is seen as key.

Align tasks and objectives to learning goals. Designers of differentiated instruction determine as essential the alignment of tasks with instructional goals and objectives. Goals are most frequently assessed by many high-stakes tests at the state level and frequently administered standardized measures. Objectives are frequently written in incremental steps resulting in a continuum of skills-building tasks. An objective-driven menu makes it easier to find the next instructional step for learners entering at varying levels.

Instruction is concept-focused and principle-driven. The instructional concepts should be broad-based and not focused on minute details or unlimited facts. Teachers must focus on the concept, principles and skills that students should learn. The content of instruction should address the same concepts with all students but be adjusted by degree of complexity for the diversity of learners in the classroom (p. 3).

Process is described as "sense making or, just as it sounds, opportunity for learners to process the content or ideas and skills to which they have been introduced" (Tomlinson, 2001, p. 79). Process activities are usually short and focus on a small number of key understandings and skills. When differentiating by process, Hall (2002) identifies a couple guidelines to help understand and develop ideas.

Flexible grouping is consistently used. Strategies for flexible grouping are essential. Learners are expected to interact and work together as they develop

knowledge of new content. Teachers may conduct whole-class introductory discussions of content big ideas followed by small group or pair work. Student groups may be coached from within or by the teacher to complete assigned tasks. Grouping of students is not fixed. Based on the content, project, and on-going evaluations, groupings and regrouping must be a dynamic process as one of the foundations of differentiated instruction.

Classroom management benefits students and teachers. Teachers must consider organization and instructional delivery strategies to effectively operate a classroom using differentiated instruction (p. 3).

The successful management of a differentiated classroom is not an easy task. However when successful, differentiation changes the role of the teacher as the central figure of knowledge or 'sage on the stage' to 'guide on the side' facilitating learning, time, space and student assessment (King, 1993). Tomlinson (2001) identifies 17 strategies for managing a differentiated classroom.

- Have a strong rationale for differentiating instruction based on student readiness, interest, and learning profile.
- Begin differentiating at a pace that is comfortable for you.
- Time differentiated activities to support student success.
- Use an 'anchor activity' to free you up to focus your attention on your students.

- Create and deliver instructions carefully.
- Assign students into groups or seating areas smoothly.
- Have a 'home base' for students
- Be sure students have a plan for getting help when you're busy with another student or group.
- Minimize noise.
- Make a plan for students to turn in work.
- Teach students to rearrange the furniture.
- Minimize 'stray' movement.
- Promote on-task behavior.
- Have a plan for 'quick finishers.'
- Make a plan for 'calling a halt.'
- Give your students as much responsibility for their learning as possible.
- Engage your students in talking about classroom procedures and group processes (pp. 31-38).

Products are important because they represent a long-term comprehensive understanding, application, and an element of curriculum ownership of students (Tomlinson, 2001). "Product assignments should help students-individually or in groups-rethink, use, and extend what they have learned over a long period of time-a unit, a

semester, or even a year" (Tomlinson, 2001, p. 85). When differentiating by product, Hall (2002) identifies a few guidelines to help understand and develop ideas.

> *Initial and on-going assessment of student readiness and growth are essential.* Meaningful pre-assessment naturally leads to functional and successful differentiation. Assessments may be formal or informal, including interviews, surveys, performance assessments, and more formal evaluation procedures. Incorporating pre and on-going assessment informs teachers to better provide a menu of approaches, choices, and scaffolds for the varying needs, interests and abilities that exist in classrooms of diverse students.
>
> *Students are active and responsible explorers.* Teacher's respect that each task put before the learner will be interesting, engaging, and accessible to essential understanding and skills. Each child should feel challenged most of the time.
>
> *Vary expectations and requirements for student responses.* Items to which students respond may be differentiated for students to demonstrate or express their knowledge and understanding. A well-designed student product allows varied means of expression, alternative procedures, and provides varying degrees of difficulty, types of evaluation, and scoring (p. 4).

Summary

This chapter reviewed research to establish a background of understanding for the main areas of this thesis including: need for transformation of teaching and learning, one-to-one computing, instructional design and differentiated instruction.

Transformation reports identify there is a *need* to adapt education for the 21st century so students can have the skill requirements to be successful in the modern workplace. 21st century skill sets require students to be lifelong learners, innovators, problem solvers, communicators, team players and to have technology know-how (Partnership for 21st Century Skills, 2009). New models of learning, identified in the reports, reviewed key items relating to what learning should look like, new methods of assessment using technology, effective methods for teaching, and educational infrastructures required for 21st century teaching and learning.

One-to-one initiatives are being implemented as an important strategy to provide students with 21st century skills. Reports of the one-to-one initiatives, in this literature review, discussed the various goals and characteristics of the initiatives. Successful implementation of one-to-one computing initiatives requires teachers to progress through developmental stages of technology incorporation. This journey transforms teachers' traditional pedagogy to technology-based pedagogy. Students are using digital cognitive devices in a variety of ways to support learning and acquire 21st century skills. Conducting research on one-to-one computing initiatives provides challenges. However,

research that has been conducted is showing positive results, especially through increased ICT skills.

The foundation of *instructional design (ID)* is learning theory including: behaviorism, cognitivism, and constructivism. As a result, good instructional design implements theories of learning into curriculum and instruction. Common characteristics and principles of design theories were presented which coincide with phases of effective instruction.

Background information on *differentiated instruction (DI)* was provided to better understand this instructional approach and its theoretical background. Steps to follow in order to DI for individual learners were illustrated by Tomlinson and Allan (2000). The literature review then focused on one of the three cogs of DI, "Curriculum and Instruction is the Vehicle" (Tomlinson, 2003). Through this cog, elements of curriculum and instruction that are important for designing 21st century teaching and learning were discussed, including curriculum that is: important, focused, engaging, demanding and scaffolded. Curriculum can be organized into three elements to effectively differentiate including: content process and product.

The analysis of this case study will now consider the relationship between each of the strategies including: one-to-one computing, ID and DI and how they enrich a grade five learning environment for the development of 21st century skills.

Chapter 3 Research and Design Methodology:

Type of Design

The design of this research study employs a qualitative paradigm through an interpretive methodology (Erickson, 1985). Characteristics of the in-depth case study present it as the preferred method to be used for the study. In contrast to positivist (quantitative) research, focusing on population and samples, this research study employs a constructivist epistemology (constructed by individual participants) where a variety of data collection methods are used to gather information on the case: a class of grade five student(s) participating in the One-to-One Digital Literacy Project (Driscoll, 2005).

A qualitative approach was necessary for this research study as a result of the interpretive and descriptive nature of data collected. Erickson (1985, p. 12) describes interpretive research as "being unusually thorough and reflective in noticing and describing everyday events in the field setting and in attempting to identify the significance of actions in the events from the various points of view of the actors themselves." A case study, with its roots alongside interpretive research, may be a more conventional term used for the research methodology used in this study (Gall, Gall, & Borg, 2007).

The grade five, One-to-One Digital Literacy Project is an event consisting of real-life participants, in a real-life setting, creating real-life experiences. It is important to bring the event to life to allow readers to understand phenomenon relating to specific

strategies (one-to-one computing, ID and DI), used in the research, for the enrichment of student learning related to 21st century skills. Characteristics of a case study (in-depth study, single or multiple instances of phenomenon, real-life context, reflects perspective of participants) and various forms of data that can be collected (process, event, person or other areas of interest) distinguish it to be the methodology of choice for this research study (Gall, Gall, & Borg, 2007). A case study is used as a result of its ability to collect qualitative data from multiple sources.

The focus on data collection is exclusively on participants of the One-to-One Digital Literacy Project. Data collection for this research study is conducted through several methods including: observation, interviews, and documentation. Data sources for the research include a selective sampling of five, from a group of 25, grade five students participating in the one-to-one initiative and, informants composed of the classroom teacher, Differentiated Instructional Facilitator (DIF), Principal and Digital Learning Consultant (DLC). The analysis of data is provided through a detailed description of emergent information within the specific case study.

The Researcher's Role

This section will discuss responsibilities and steps taken by the researcher in this qualitative study. Topics covered for this section include: experiences of the researcher, steps for school division approval, steps for ethics approval and confidentiality of information.

The researcher is a Digital Learning Consultant employed with the School Division where the research study was conducted. As one of the team members for the One-to-One Digital Literacy Project, the researcher is responsible for overseeing the one-to-one project. Responsibilities include supporting both the teacher and students through long term, reliable presence with technology adoption. Another role of the researcher is to participate in the collection of data and reporting of results. This role provides a unique context to participate in the one-to-one classroom environment to support both the teacher and students throughout the duration of the project.

Although the role and context intensifies the researchers' sensitivity and knowledge regarding multiple aspects of the study, it has bias. The researcher declares certain biases regarding this study. Efforts have been made to establish an impartial research study as identified, in the data collection section of this thesis. However biases may shape the interpretation of data collected as a result of the diverse functions required by the researcher as a participant in this study.

Steps taken to receive Divisional approval of the One-to-One Digital Literacy Project began in February 2010 with a project proposal submitted to the Superintendent of Schools by both the researcher and school principal. The proposal for the One-to-One Digital Literacy Project was then taken to the Technology Reference Committee where it was granted approval to begin in September 2010.

As a member of the One-to-One Digital Literacy Project and concurrently enrolled in graduate studies at the University of Saskatchewan, the researcher decided to write a graduate level thesis on the ubiquitous computing project. The researcher requested and was granted permission by the Superintendent of Schools in September 2010 to complete a graduate level thesis on the One-to-One Digital Literacy Project.

Research conducted in this study required prospective subjects and informants to provide free and informed consent about participating in the study; their free and informed consent was maintained throughout the duration of the study (Canadian Institutes of Health Research, Natural Sciences and Engineering Research Council of Canada, Social Sciences and Humanities Research Council of Canada, 2005). The process for acquiring consent was to:

- *First*, receive approval from the School Division to invite potential participants (see Appendix A).
- *Second*, invite the Grade Five Classroom Teacher, Differentiated Instruction Facilitator and School Principal to participate through an invitational letter (see Appendix C).
- *Third*, receive free and informed consent from both authorized representatives (parent or guardian) and participant themselves through a letter of invitation based on the U of S BeREB Consent Form Template (see Appendix B).

Due to the age of the grade five students, they were not legally allowed to provide free and informed consent; therefore, the Tri-Council Policy Statement on Ethical Conduct for Research Involving Humans requires the following research conditions to be met (Behavioural Research Ethics Board, 2010):

> Subject to applicable legal requirements, individuals who are not legally competent shall only be asked to become research subjects when:
>
> - The research question can only be addressed using individuals within the identified groups; and
> - Free and informed consent will be sought from their authorized representative(s); and
> - The research does not expose them to more than minimal risk without the potential for direct benefits for them (p. 6).

Data gathered from this research study includes information relating to individual subjects of the grade five classroom. It is necessary to keep names of participants private and secure, and research data confidential, only accessible to members of the research team. Data from this research is to be used for the intended purpose and any publications resulting from the research will maintain the confidentiality of participants.

Data Collection Procedures

Creswell (1994) identifies three steps for data collection namely, setting study boundaries, collection of information, and protocol for recording information. Data collection procedures used for this research study include observation, interviews, documentation and audio recordings.

The research took place in an elementary school situated in a rural community located North Eastern Saskatchewan. The focus of the case study was a grade five one-to-one learning environment, newly implemented in September 2010. The one-to-one learning environment consisted of a classroom teacher, differentiated instruction facilitator (DIF), and 25 grade five students, each provided with a netbook for 100% of their classroom time. Unsure if netbooks should go home with students, a decision was made by the One-to-One Digital Literacy Project Team not permitting students to take the netbooks home. The grade five classroom teacher is an experienced teacher with 20 years teaching experience and would be at, what Penuel (2005) describes, the *adoption* stage of technology incorporation, where new technology is used to support traditional instruction. Supports for the classroom included a Differentiated Instructional Factilitator and Digital Learning Consultant who provided the teacher and students with curriculum, instruction and technology assistance. Specialized IT support was provided by the division Technology Services department.

Along with providing 28 student netbooks, the classroom is equipped with various tools to assist with technology-based learning. The grade five classroom contains a desktop computer connected to a projector, document camera, audio speakers, webcam and microphone. Students have access to a 32" LCD TV, two Flip cameras, two portable USB scanners, a Fusion writer and one digital camera. The school has been outfitted with a wireless network providing wireless access throughout the entire school.

The teacher and students have access to a wide array of software applications. Both local computer-installed applications, and web-based applications are used to assist with technology-based learning. Some of the main applications used are a learning management system (LMS) Moodle, Google Apps, Microsoft Office, Wikis (Wikispaces), blogs (Blogger) and Skype. These applications allow for various processes including instructional delivery, online access, collaboration, discussion, reflection and communication.

Participants for the research included both the subject(s) of the case study and informants. The subjects were the student(s) on which the case study focused. Informants included the classroom teacher, DIF, Principal and DLC(s). The focus of data collection was on phenomena observed as occurring around specific strategies to enrich 21st century learning in the grade five one-to-one learning environment. Through an investigative approach, emerging events provided information on the subject(s) related to the case study.

The case study approach for this research lends itself to multiple forms of data collection. Multiple forms of data collection can improve the strength/trustworthiness of a case study through the triangulation of data sources to see if conclusions are substantiate across diverse strategies (Gall, Gall, & Borg, 2007). Various forms of data collection used in this research study include: direct observation, interviews, documentation, and audio recordings. For further information relating to data collection purpose, potential benefits, potential risk, storage of data , confidentiality, and right to withdraw, see Appendix A, B and C.

Observation. The first format method used to collect data for this research study was observation. A type of observation called naturalistic observation allows observers to gather field notes by directly observing the behaviour and social and physical environment of the case study subject(s) in their real-life setting (Gall, Gall, & Borg, 2007). Observations of the subjects in this study were conducted in the natural setting of the grade five classroom. Observational data was collected by multiple informants working with the grade five students including: classroom teacher, DIF, DLC (researcher) and DLC (other than researcher). Multiple informants allowed for the triangulation of observational data to deal with research/observer biases and assist levels of trustworthiness and validity.

Features of the phenomena on which observers focused were recorded through field notes in the form of handwritten text, computer word processor, personal project

related blogs and audio recordings. Observational field notes included both descriptive and reflective items relating to the phenomena (Gall, Gall, & Borg, 2007).

Throughout the data collection phase of the study, the number of direct classroom observations by multiple observers was between four to six observations. Each observation was to be 90 minutes in length. During direct classroom observations, the observers used predetermined observational protocol to record information (see Appendix D).

Interviews. A second procedure used in this study, for gathering qualitative data, was interviews. The *semi-structured interview* was used, allowing the interviewer to ask a series of structured questions but permitting probing with open-form questions to obtain greater depth and more meaningful information (Gall, Gall, & Borg, 2007). Semi-structured interviews provide researchers more flexibility and adaptability to gather meaningful data through the perspective and insight of interviewees who have experienced the phenomenon (Creswell, 1998).

In this research study, semi-structured interviews were conducted with one respondent at a time, including both subjects (grade five students) and informants (teacher, DIF and Principal). Interviews conducted with the research subjects (grade five students) were administered by a Digital Learning Consultant, other than the researcher for ethical reasons, and scheduled at a mutually agreeable time between student, teacher and interviewer. Five separate student interviews were conducted lasting no longer than

30 minutes and took place in a private room or office; all interviews were audio-recorded. Audio-recordings were then transcribed to a text document and uploaded to NVivo9™ for analysis. Interview questions for subjects are available in Appendix E.

Interviews with informants (classroom teacher, DIF and Principal) were administered by a DLC, other than the researcher for ethical reasons, and scheduled at a mutually agreeable time between interviewee and DLC. Interviews with informants were to last no longer than 60 minutes and take place in a private room or office; all interviews were audio-recorded. Audio-recordings were then transcribed to a text document and uploaded to NVivo9™ for analysis. Interview questions for informants are available in Appendix F.

Documentation. A third data gathering procedure used in this research study was *documentation*. This method authorized the researcher, informants and subjects to keep journals or blogs throughout the duration of the study. Also, photographs, video and audio recordings of subjects, in the case study environment, were used to capture and document events. Other forms of documentation that were analyzed during the study included assignments, activities and assessments of the subject(s).

Data collection took place throughout the period of January 1, 2011 to June 30, 2011.

Data Analysis Procedures

Data analysis procedures differ when incorporating a quantitative approach opposed to a qualitative approach (Charles, 1998; Creswell, 1994; Gall, Gall, & Borg, 2007). Evidence from a qualitative case study may be interpreted through strategies including: categorical aggregation, direct interpretation, patterns and naturalistic generalizations (Stake, 1995). The data analysis of this case study promotes an environment where a pipeline of information is described from simultaneous events and transcribed into narrative writing. This is a process similar to what Tesch (1990) describes as de-contextualization and re-contextualization: "While much work in the analysis process consists of taking apart (for instance into smaller pieces), the final goal is the emergence of a larger, consolidated picture" (p. 97).

Qualitative data for this case study were analyzed through two approaches identified as interpretational analysis, and reflective analysis. "*Interpretational analysis* is the process of examining case study data closely in order to find constructs, themes, and patterns that can be used to describe and explain the phenomenon being studied" (Gall, Gall, & Borg, 2007, p. 466). Steps for interpretational analysis of data include: compiling data into a database, developing categories, coding segments, grouping category segments and drawing conclusions. A qualitative data analysis software program, NVivo9™ was used for interpretational analysis.

"*Reflective analysis* is a process in which the researcher relies primarily on intuition and judgment in order to portray or evaluate the phenomenon being studied" (Gall, Gall, & Borg, 2007, p. 472). The reflective analysis approach was necessary in this research study to generate rich descriptions, through connoisseurship and criticism of phenomena that was not suited for interpretational analysis. The researcher of this study additionally considered reflective analysis advantageous in situations where members of the research team could collaborate in order to come up with richer interpretation and new more complete meaning of phenomena.

Chapter 4 Results:

Research procedures including data gathering and data analysis followed the strategies described in Chapter Three. This section provides the research results and further details the interpretational and reflective analysis strategies used.

Overview of research procedures

Data collection sources for this research study used semi-structured interviews, direct classroom observations and documentation through blogs as primary data gathering procedures. A total of five student and three informant interviews were conducted during the study. Corresponding interviews conducted used either the Subject Interview Protocol (Appendix E) or the Informant Interview Protocol (Appendix F). Data gathered for both subject and informant interviews were captured through digital audio recordings using a digital recording device. An external online transcription service was used to transcribe the audio into text transcripts which was then provided in a digital document (MS Word) format.

A total of four classroom observations were conducted by the classroom teacher, DIF, DLC (researcher) and DLC (other than researcher). Observational data was recorded in written form using the Observational Protocol (Appendix D). Each hand-written classroom observation was then transcribed into MS Word to create a digital copy of the observational data. Digital formats of both the interviews and observations were necessary in order to upload into NVivo9™, the qualitative analysis software.

Documentation data was gathered through online blogs. The grade five classroom teacher, Differentiated Instructional Facilitator (DIF) and Digital Learning Consultant maintained blogs for journaling purposes throughout the research study. Posts from the blogs coded into NVivo9™ to allow for further analysis.

NVivo9™, a qualitative analysis software application, aided to de-contextualize the unstructured information and re-contextualize it into categories or themes (Tesch, 1990). Interview transcripts and observational documents were uploaded into NVivo9™ and coded into categories. Coding is the process of examining the data in detail, "looking for things pertinent to answering the research question" (Foss & Waters, 2003). Data from interview transcripts and observational documents pertaining to research questions were coded into the corresponding categories. NVivo9™ provided an efficient way to organize data into coded categories to further analyze and "co-create a story with the data" (Foss & Waters, 2003).

The main categories used to interpret the data were pre-structured and organized around the study's questions including 1:1 computing, instructional design, differentiated instruction and how these strategies might enrich 21st century learning. Additional emerging categories (emergent themes) that arose throughout the coding were added under each of the main categories for further data analysis. The emergent themes result in an important and legitimate process for qualitative, case study research. Out of the emergent theme process unexpected or unanticipated results may appear which could prove to be an important aspect of the research.

The structure of the categories is provided in the Data Analysis Categorical Chart shown below in Figure 12. Four pre-structured categories are shown at the top of each column (21st Century Skills, 1:1 Computing, Instructional Design and Differentiated Instruction). 21st Century Skills sub-categories were prescribed by the skills associated with 21st century learning. Other sub-categories were emergent from coding the data.

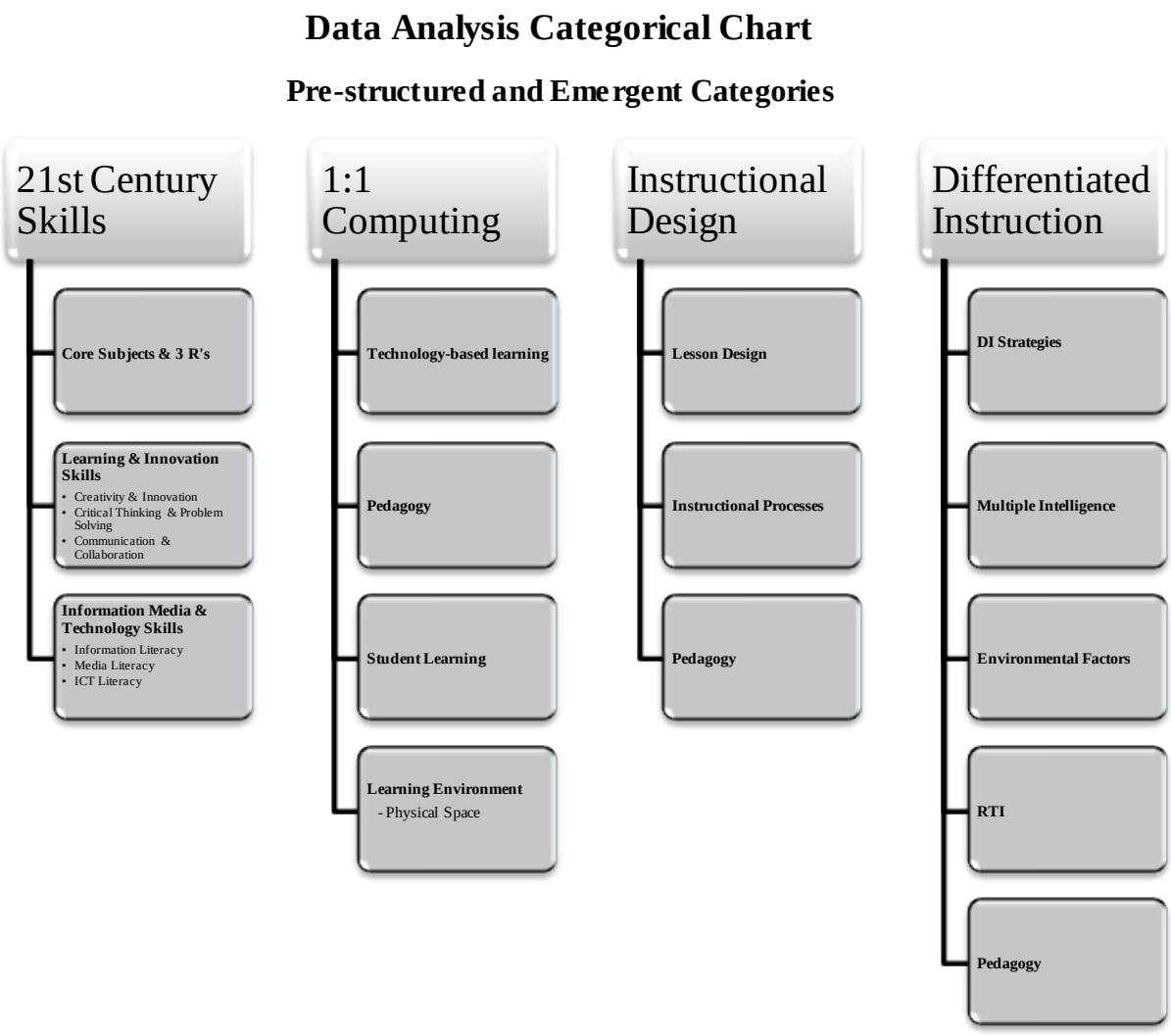

Figure 12: Data Analysis Categorical Chart

Description of Results

This research study explored the enrichment of teaching and learning for providing 21st century skills to students in a grade five classroom through three distinct strategies including one-to-one computing, instructional design and differentiated instruction. Results for this qualitative study are organized and presented around the questions of the research. Results will first focus on the main question, namely, examining the significant enrichment effect each of the three variables, under investigation, has on a grade five learning environment for the development of 21st century skills. Results targeting the following sub-questions will then be presented in this particular context:

- How do *instructional processes and pedagogy* differ in a technology-based learning environment in contrast to traditional learning environments?
- What can we learn about the *design of instruction* in a one-to-one computing environment as compared to traditional classroom-based learning environments?
- What is the *process of instructional design* regarding *learning resources* as they are utilized through one-to-one computing environments?
- How can *instruction be designed* in a one-to-one environment incorporating *differentiated instruction*?

Significant enrichment effect of each variable.

Physical Space. One theme that developed under the categories of 1:1 computing and DI was the physical design and layout of the learning environment. Observational results, interview transcripts and blog posts by the classroom teacher, students, and Differentiated Instruction Facilitator (DIF) indicated that time was spent enriching the physical space through strategies including Differentiated Instruction (DI), Response to Intervention (RTI) and technology-based learning.

Transcript and observational data revealed that tables replaced desks which had students sitting in learning pods designed for collaboration. An observation transcript from one of the informants describes the students' classroom routine as settling in with netbooks at tables consisting of three to four students per table. Student Privacy shields were used when there was a want or need for students to focus on individual work. The classroom teacher stated, in the interview transcript, that "privacy shields were seen as a useful strategy for allowing students to work independently within the classroom environment."

The classroom teacher, through a blog post, described bringing an occupational therapist, employed by the school division, into the classroom. The occupational therapist first observed and second presented, to the students, a lesson about proper posture while sitting and using netbooks.

A multi-level prevention strategy that maximizes student achievement and reduces behaviour problems, know as Response to Intervention (RTI) (National Center

On Response To Intervention, 2011), was identified, through transcripts of both the classroom teacher and DIF, as being implemented into the learning environment. A process known as "draping" was used to cover open cupboards with cloth to restrict the view of content. Also clutter was removed from the learning environment to limit distractions. As supported through following quote from the transcript of the DIF:

> "Another thing that I've noticed is that the removal of a desk means that they have a space in the center of the table for just a few items, instead of having a lot of books and things, and a special pen that maybe they got and, you know, hands in desks and playing around with that. So that distraction is certainly taken away, which would benefit the focus of students."

Flexible areas were set up in the classroom for students to self-regulate. A student interview transcript describes the self-regulating space, "for self-regulating, if we can't see we can just go back there or work there if we want."

Interview transcripts from the classroom teacher, DIF, and students identified that subdued lighting provided a feeling of comfort to the learning environment. Lamps were added to the space throughout the classroom to provide a cozier atmosphere compared to what traditional fluorescent lighting would provide. Three students expressed, in their interviews, that they believed the lamps to provide a calming and cozier atmosphere to the classroom.

Observations of the grade five learning environment identified additional items within the classroom. Two netbook storage carts were placed in the room to house and charge the netbooks when not in use. Plug-in areas within the room were identified for students to plug-in netbooks during class time if necessary. An overhead projector and document camera were connected to the teacher's computer workstation. Students increased collaboration by connecting their netbooks to a wall mounted 32" LCD TV. Two scanners connected via USB were added to the learning space for students to use. Each student and classroom teacher, in the learning environment, was outfitted with a 10" netbook computer. The illustration (Figure 13) below represents the physical layout of the grade five learning environment, redesigned to accommodate one-to-one computing and facilitate 21st century learning.

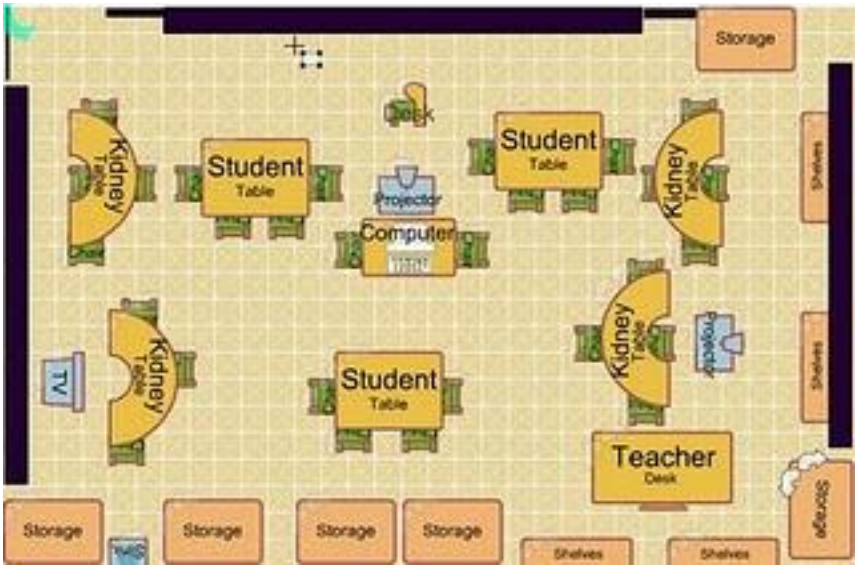

Figure 13: Physical layout of grade five learning environment (Kezema, 2010)

Pedagogy. A second theme which had connections to categories including 1:1 computing, Instructional Design and Differentiated Instruction, was the acceptance and resilience to change of pedagogy by the classroom teacher. The interview transcript of the school Principal described the classroom teacher's pedagogy moving from the 'sage on the stage' to more of a 'guide on the side.' A blog post, by the DIF, expressed how the traditional role of the teacher transformed from direct teaching, wherein we dispense vast amounts of knowledge to students, into more of a facilitator of learning role.

Data analysis identified the classroom teacher and Differentiated Instruction Facilitator (DIF) coming to terms with the concept of 'letting go.' They found issues with the literal perception of the term which they understood to mean; get out of the way and let students find their own direction. Support of this is found in the teacher interview transcript:

> "I've heard through different conferences like the IT Summit that with technology just let it go, you know, let the kids lead, and really that is true to a point because you have to be flexible in your teaching. But I've found that I'm more organized this year than I have ever been because of my instructional design, the ability to design."

The classroom teacher and DIF believed a better interpretation of 'letting go' was characterized by terms such as pedagogy, flexibility, facilitation, organization, humility and trust. From the teachers' perspective, thoughtful and intentional instructional design led to their ability to 'let go', in turn allowing them to facilitate learning in the classroom.

Curriculum, Assessment and Instruction. Study results, concluded from interview transcripts of the teacher, DIF and Principal, indicate that the focus of the one-to-one learning environment to be on curriculum, assessment and instruction. Interview transcripts reveal the school Principal believed curriculum to be the key to successful implementation of a technology-based learning environment. Found in the following:

> "At the heart of everything, curriculum was still number one, and that was evident when you walk into that classroom. Technology is definitely a resource or a tool just like a pencil or pen would've been a couple years ago, but it doesn't even stick out to me when you walk into that classroom."

To focus on curriculum, assessment, and instruction, the classroom teacher made use of Understanding by Design (UbD), a conceptual framework emphasizing a "backward design" process using outcomes to design curriculum tasks, performance assessments and classroom instruction (Wiggins & McTighe, 1998). Transcript results from the DIF describe when designing instruction, "You have to know curriculum, know your outcome, understand planning and start with the end in mind."

Traditional vs. Technology-based Instructional Processes and Pedagogy. Previous sections of this thesis have generally highlighted the educators', involved in the grade five one-to-one environment, beliefs towards change of pedagogy from traditional to technology-based. The focus of this section is to discuss results of how instructional processes and pedagogy altered in the one-to-one computing environment using

technology-based pedagogy, compared to, more traditional learning environments using traditional pedagogy.

Technology and Instruction. Data analysis indicates that educators within the grade five learning environment believed technology was necessary for delivering students a more authentic learning experience. As expressed by the classroom teacher, "Technology, I believe, will get them there but it's how you use the technology too." However, educators questioned the ability for netbooks, in of themselves, to be the entire solution for enriching learning experiences. Educators' conceived technology, along with instructional processes incorporating technology-based learning, to be important aspects for enriching the learning environment. Transcript data from the teacher reveals, "So just having netbooks in a classroom isn't going to do it but instruction, incorporating technology and having the kids actually have authentic learning experiences using technology, I think will build those 21st century skills."

Multiple Layers. This section describes instructional processes used within the grade five one-to-one learning environment that have focused on technology-based pedagogy crossing the multiple layers of 21st century skills (illustrated below in Figure 14, as well as earlier in Figure 1). The teacher identified in their interview transcript, how technology was a natural fit to teach and for students to develop 21st century skills. The school Principal believed that, although, some 21st century skills stood out, such as information, media and technology skills and learning and innovation skills, all 21st century layers were met.

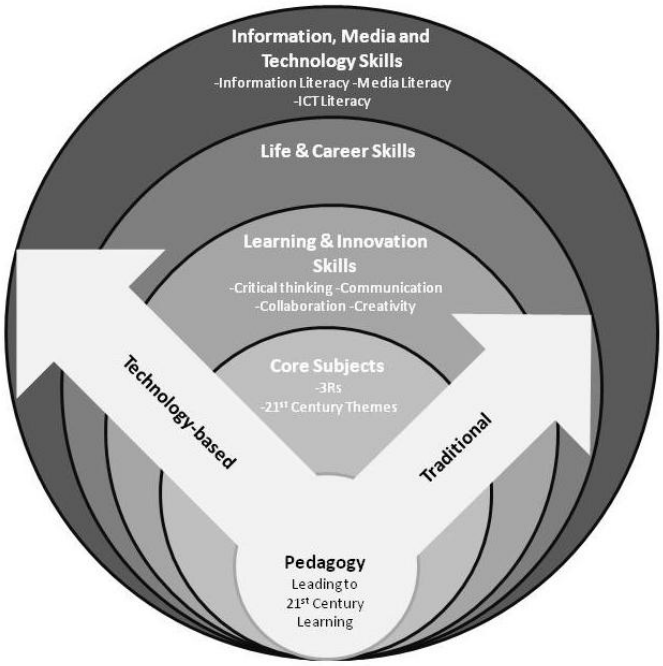

Figure 14: Traditional vs. Technology-based Curriculum and Instruction for 21st Century Learning

Core Subjects. First, core grade five subject tasks including: ELA, Math, Science, Social and Health were designed into and delivered through a Learning Management System (LMS) called Moodle. One student interview transcript described "pretty much all" subjects were available through Moodle. Another student identified, "We have computers and we do all our work on computers except for a few subjects like French and Phys Ed." The classroom teacher thought "Moodle was a very good tool to use; also the idea of having assessment embedded in it was huge for me because I could give kids immediate feedback." A student explained how they saw Moodle assist in the learning environment, "Moodle helps you if you don't want to go ask the teacher, you can go on without always asking the teacher."

Student interview transcripts provided results identifying reading, writing, and overall student learning was affected by the one-to-one environment. One student described how they felt they were able to become a better writer in the one-to-one environment as a result of the netbooks. This same student identified that assignments were easier for them to complete, in the technology-based environment, because they were able to use technology to assist them with difficult areas such as reading and writing. Another student explained, "I think when I am on the netbook, I can learn more easily." The student goes on to support their answer by identifying "It is better than just having the teacher talk about it and write on the white board and so you can read over if you missed anything."

Learning & Innovation Skills. Second, learning and innovation skills such as critical thinking, communication, collaboration, problem solving, and creativity were a focus within the grade five one-to-one computing environment. Described in the Principal's interview transcript, is a belief that students in the grade five one-to-one environment were able to *critically think* and choose how they wanted their products to look, whether it was technology-based or not. The Principal also stated that they saw more technology-based choices by students, things that they would have never expected the students to be using for research, presenting their knowledge, or creating their product. The classroom teacher identified that students "became really good self evaluators" with the assistance of technology such as Moodle. Through Moodle, students

were provided responsive teacher feedback and accessible online rubrics, students were able to view rubrics, assess themselves, and resubmit assignments.

Interview transcripts identified that *communication* has evolved among the students in the grade five one-to-one environment. The classroom teacher described how students were very fearful to communicate at the beginning of the year, "Students were afraid they might be telling another student an answer." The teacher explained how this has changed, "One of the big turnarounds has been that the kids have really learned how to learn from each other and talk to one another and communicate with each other."

Collaboration was identified, through interview transcripts of all informants (teacher, DI and Principal) and four out of five of the interviewed students, as an important strategy used in the grade five learning environment. The DIF explained, "The physical organization of the room presents an environment where students are more likely to want to talk to somebody else, to join up with somebody of their same or different learning style." One student expressed an increase in classroom collaboration "because you're sitting in pods. Another student expressed their appreciation for the learning environment, "because you can collaborate with other people and you have help when you need help." A third student explains what collaboration may look like in the grade five technology-based learning environment. The student commented:

> "Well, we all sit at a table and we would take out our netbooks, and let's say we wanted to research something huge, we would split up into sections and one person would research this, another person would research that. Once you're all

finished we would just put it together into one big thing and we would type down what each other had to make a bigger thing so that the answer wouldn't be just, like, really short like a sentence. We would put it all together so that it would be one big paragraph."

Interview transcript analysis identified that students in the grade five one-to-one environment were active with *problem-solving*. The classroom teacher stated, "I see 21st century themes, I think problem-based, I think inquiry-based, is what we want the kids to really delve deeper into different themes and to find out information that is important to them." The DIF explained how students have grown in the learning environment, "Problem-solving is another thing that has come absolute miles with this group." The DIF believed students not only increased their problem-solving skills of technology (ICT skills) but were also able to problem-solve in terms of the lesson, "if there's an option to show what they know in different ways, then they look at it and say these are my strengths to be able to show the teacher how much I know about it." All five of the students interviewed touched on problem-solving in the one-to-one learning environment. All students talked about how they were able to better problem-solve computer issues however, two also discussed how they liked tasks allowing them to problem-solve and have choice in how they present their findings.

Life & Career Skills. Third, interview transcript analysis established life and career skills being taught within the grade five one-to-one computing environment. The school Principal saw lifelong career skills being taught in how students were given the

opportunity, often alongside the teacher, to learn with technology. The principal explained this as an opportunity for "students to be leaders in the classroom, to lead other people." The DIF expressed, "It may be a little early for life and career skills, but they're ten and they have to start realizing that the skills they are learning through technology will be part of their lives, something that they use in a presentation to get a job someday." The classroom teacher saw each student creating an e-portfolio and building on it throughout their k-12 years benefitting their life and career skills. The classroom teacher explained, "Students use a digital format for the work they have done at Grade five, and if we can continue that throughout their academic career, what a beautiful resume to show potential employers." A student touched on how they saw technology skills assisting them in college:

> "I probably learn more with the netbooks because you learn more stuff about technology and then when you get into college you'll know all that stuff, you won't have to go through it. Well, you'll still have to go through it but you'll know most of it when you finally get to college. Let's say you wanted to be a technician or something, you would already know that because you would have experience with all this technology."

Information, Media & Technology Skills. The fourth and final layer necessary for 21st century learning is information, media and technology skills. This section will present the results of the instructional processes and pedagogy found in the grade five one-to-one environment relating to information, media and technology skills.

Interview transcript analysis shows that the classroom teacher believed grade five students participating in the one-to-one learning environment were pretty good at information, media, and ICT literacy. The teacher described a focus on using an authentic approach for students learning these skills. The teacher believed the authentic approach was partially due to the fact that computers were fully accessible to be used in the classroom, but also included how these skills were taught through tasks directly related to curriculum outcomes. The classroom teacher explained how information, media, and ICT literacy skills were not taught in isolation, but designed authentically into curriculum-based instruction to provide students with these skills.

The Principal indicated that the grade five students are digitally inclined, "They understand that the computer can be used as a tool, and it's become an extension of them, pulling it out when they need it." The Principal also spoke about authentic ways of using technology and social media in the classroom, "We can fool ourselves thinking that in a traditional learning environment that we're going to teach 21st century skills, because it's not authentic."

The DIF saw not only ICT skills increase in students but explained how using new forms of media and technology as a natural way of learning for students. The DIF interview transcript stated, "If you are in a traditional classroom you can still be creative but with technology it is bigger, it opens so many more opportunities for students in terms of 21st century learning."

Student interview transcripts identified that students were happier using technology and believed they learned more about technology, computers and software applications in the grade five one-to-one environment. A student's feelings were expressed through their statement, "I'm just more used to computers and I just feel, kind of, happier and work better near a computer." Another student interview explains, "I learned a lot about technology this year, I have learned how to do work on the computer and how to write stuff on the computer like in Word 2007 you can write your own stories there and put in pictures." A third student touched on digital citizenship in describing how one activity was created using Glogster and permissions had to be set properly. The student stated, "You have to make sure it is private so only people, like your teacher or friends can see what you are doing not people all around the world because then they could find out your personal information." A fourth student interview explained how technology was used to assist them, "If you don't understand something you can just type it into Google Translator or something like that and then just listen to it to see if it sounds right or wrong."

One-to-One Computing & Instructional Design. This component will provide results of how instruction was designed in the grade five one-to-one computing environment. One of the characteristics in the grade five learning environment, changing how instruction was designed, is the fact that each student had access to a netbook. The teacher explained, "It's a time factor when you're going to a lab, for us it is fast, we can implement it because we don't have to go to a lab where the computers weren't plugged

in so they're not going to work." The Differentiated Instructional Facilitator (DIF) saw access to netbooks as a tool to drive the instruction, "Technology is just a tool and if your instruction isn't solid the technology is not going to do it for you." The Principal described access to netbooks as something that engaged students. The Principal revealed in their interview transcript, that students live digitally outside the school walls and to engage students we must use technology-based learning in classrooms to provide 21st century skills.

Instruction in the grade five one-to-one learning environment embraced advantages of technology-based characteristics but also included components of traditional strategies. Characteristics of *Technology-based* instruction, found in the interview transcripts, was described by students, classroom teacher, DIF and Principal as: accessible online to students and parents (Moodle, Wikis, Google Sites), built-in assessment, network-based, collaboration through web-based tools including Skype and Google Docs, online access to additional student work, included audio and video, included links to rubrics and organizational sheets, included links to web-based resources, and handing in assignments by uploading to LMS (Moodle). Characteristic of *non-technology-based or traditional* instruction were presented through interview transcripts as: well planned, curriculum and outcome-based, step-by-step, problem-solving or inquiry-based, student-centred, facilitated, flexible, choice-related, differentiated, allowed for various learning styles, and used the UbD philosophy.

The school Principal saw the overall structure of the instruction as the key. As described in their interview transcript:

> "I think one of the key things that we would see would be just the overall structure. From the students being able to log onto a computer to see what their day looks like, to a parent being able to have access to see what activities their student, their child is working on, what may be due, what they have completed and so on."

Intentionally, the design of instruction in the grade five learning environment incorporated numerous outcomes from multi-curricular areas through a combined Understanding-by-Design (UbD) and Analysis, Design, Development, Implementation, and Evaluation (ADDIE) approach. Further details on the ADDIE approach are provided in the Chapter 5 Discussion. Key items to assist in the instructional design process were identified as understanding the planning process, starting with the end in mind, organization and knowing the purpose.

Wanting to design authentic learning experiences, based on real-life scenarios for students, the grade five teacher adopted a problem solving, inquiry-based approach. Throughout the design process, attention was given to a variety of design aspects including: online access, grade level specific content and language, assessment, diversifying instruction to support student learning, necessary steps required to solve problem and resources to be used in instruction.

Interview transcripts, further discussed in chapter five, identify students who accessed online instruction appeared to provide positive feedback. Comments by students describe their appreciation for instruction including: web-based access, ability to re-read, step-by-step format, diversified, multi-media, problem solving, additional resources and written grade level specific.

Applying Learning Resources in a One-to-One Computing Environment. This section of the thesis will identify results on processes and circumstances which contributed to technology-based resources being applied in the grade five one-to-one environment. As a result of transcript analysis three categories appeared in which to organize processes and circumstances affecting technology-based learning resources used in the grade five learning environment. These three categories include: teacher deliberately designed instructional resources, student initiated resources, and student unique learning resources.

Deliberately designed instructional resources were technology-based resources the teacher placed into instruction to assist students in understanding, designing, creating, communicating, or collaborating a process, concept, or idea required by the learning outcome. These resources came in many forms, and were identified as: websites, digital documents (rubrics, graphic organizers), audio recordings (Audacity, Sound Recorder, Audio Boo), screen captures and instructional videos (Jing), content videos (YouTube, TeacherTube, Google Video, Vimeo, BrainPOP), online discussions (Wikispaces, Google Sites, Voicethread), online games (Privacy Playground, BrainPOP), web-based

communication (Skype), web-based collaboration (Google Docs, Wikispaces, Google Sites), satellite imagery (Google Earth), online maps (Google Maps), and online vocabulary and flashcards (Quizlet).

Student initiated resources were technology-based resources that were identified by the student to assist them in understanding, designing, creating, communicating, or collaborating a process, concept, or idea required by the learning outcome. Student initiated resources found in the grade 5 one-to-one classroom included: Text to speech (iSpeech), spell check (MS Word, Google Docs), digital documents (MS Word, Google Docs), digital presentations, movie making and storytelling (Prezi, Nota, DSI Flipnote, Movie Maker), digital posters (Glogster), online comics (Comic Creator), audio/voice recordings (Sound Recorder, Audacity), video (Flip cameras) and online communication (Skype).

Student unique learning resources were specialized technology-based resources that were identified by the teacher or other professionals (e.g. Differentiated Instructional Facilitator, Digital Learning Consultant) to assist students in understanding, designing, creating, communicating, or collaborating a process, concept, or idea required by the learning outcome. One example of a student unique learning resource used with a student in the grade five classroom was a Fusion Writer. This specialized tool allowed for spell checking and word prediction to be used by the student when writing.

Differentiating Instruction in a One-to-One Computing Environment. One of the most notable areas for this research study may arguably be in the area of using an instructional design approach to differentiated instruction in a one-to-one computing environment. Findings of this research study attempt to present a clearer understanding of how differentiated instruction (DI) can be incorporated, through the process of instructional design (ID), in a one-to-one learning environment. This section will discuss DI discovered in the grade five learning environment as a result of intentional planning of management strategies, curriculum and instruction. An overview of DI management strategies (Tomlinson, 1999) is presented followed by a more in depth focus on the process of instructional design incorporating DI into instructional content within the grade five one-to-one computing environment.

Observers and educators of the grade five learning environment concur with Benjamin (2005) claiming that features of technology-rich learning environments, in many situations, naturally allow for differentiated instruction. This is supported through the interview transcript of the differentiated instructional facilitator (DIF), "It just lends itself to differentiated instruction and I keep going back to the audio and visual, those are the types of learning styles some kids have and as a teacher trying to facilitate that without technology, it's tough."

Tomlinson (2003), a leading researcher and author of differentiated instruction (DI), describes five characteristics of effective curriculum to include: address important curriculum, focus on outcomes, engaging, demanding and scaffolded. This section will

now examine processes of instructional design that incorporated DI into the grade five instructional content using the five characteristics identified by Tomlinson.

Address Important Curriculum & Focused on Outcomes. Interview transcript analysis suggests the team of educators in the grade five learning environment dedicated a great deal of time reviewing curriculum in the planning and designing phase of instruction. A focus on curriculum outcomes was met through the UbD process. Planning of instruction using the UbD process reviewed curriculum and "unpacked" outcomes. This process resulted in educators intentionally designing flexible student tasks and activities focused on curriculum outcomes suitable and relevant to learners. The teacher interview transcript expressed a focus on cross-curricular outcomes, "It's not what subject we're working on, it's what outcomes and the outcomes can be from different subjects." Student instruction, incorporating curriculum-based tasks were accessible online through Moodle, Google Sites or Wiki Spaces. One student enjoyed having access to online instruction for homework purposes, "And the good thing about that is we can do homework at home on a computer." Tasks were written in grade level appropriate language and began with displaying learning outcomes. This DI strategy provided students with what they needed to know, understand and do in relation to curriculum-based tasks.

Engaging. Classroom observation transcripts reveal that comments written by observers indicated students in the grade 5 one-to-one computing environment were engaged in their learning. One observer's comment stated, "Students were engaged for the entire 90 minute observation." Transcript analysis identifies a variety of methods used to design and deliver, engaging, technology-based instruction in the grade five learning environment. For example, providing each student with a netbook was one strategy used to engage students in the grade five one-to-one environment. Interview transcripts indicate that students generally enjoyed learning with the netbooks. One student expressed,

> "I just like using the netbooks and not always having to do your work on paper because sometimes paper gets a little bit boring. So sometimes you want to spice up your work with something cooler. You could put word art and pictures and stuff on your assignments that are due."

It should be noted that, although, all five of the students interviewed, identified they were excited to be using their own computer in the classroom, one student initially showed signs of apprehension and fear. The student interview transcript revealed,

> "When I came in the classroom at the very start of the year, I thought it was going to be pencils and paper again, and probably most of the other students thought that too. And then when they see that there's netbooks, there are computers everywhere and there's technology everywhere they were probably just like, "Oh, now we have to try to learn a different learning style and try to get used to this." I

was just thinking, "This is going to be the worst year ever", and it turned out to be the best year."

Students' accessing online instruction and resources through one-to-one computing and other forms of technology-based learning was another strategy used to engage students. The classroom teacher shared their perspective of student skill development through online instruction, "The way I'm designing instruction lends itself to 21st century skills, and traditional classrooms don't have that same opportunity." A student interview transcript identified exciting new skills they gained through using the netbooks, "You learn how to use the Internet, but not to mess around on there or you can get in really big trouble, and a whole bunch of different stuff that you've probably never really experienced before, like Glogster, Skype, Wiki Spaces, all that stuff." Students appeared to be motivated and engaged when participating in collaborative activities with distant students through online communication tools such as Skype. A student interview transcript describes their excitement regarding Skype, "Let's say I'd never seen Skype before then the teacher comes and says, "We're going to go on Skype", and then pulls it up and then I can learn from that and then just know what Skype is…It is really interesting." The school principal shared their view of online collaboration, "You know, even through using Skype, it's shown the students that this is a way of learning and sometimes if we can't find the answer ourselves, we can go to other people to help us find them."

An additional strategy used to engage students in the one-to-one learning environment was instruction designed through a problem-solving, inquiry-based learning approach. The following quote from the DI interview transcript describes the instruction.

> "In terms of the students, lessons are very, very clear, they're very, very step-by-step, and there's lots of options provided for them. So when they look at a lesson, they can show what they know in a variety of ways, as opposed to it just being, okay I've given you my information now here's the worksheet, everybody turns it in, either you did it or you don't do it. Students are able to upload those assignments, the teacher can see right away who's got it handed in. There's some transparency there. Some monitoring of students' progress. So they can say okay, I've got 19 out of 25, I need to make sure I touch base with those students at the end. Built within those lessons of course is audio support and visual support and those kinds of things for those students where in a traditional classroom you might of course know that that's what's needed, but you'd have to physically take those kids over to the corner and sit down in a group. And so now and then my back might be turned to the rest of the group and, you know what's being raised and putting onto blocks over here while you're dealing with the needs. These kids need that, but how do I get that while I still maintain some monitoring of what's going on in the regular classroom."

Demanding. One characteristic of demanding curriculum and instruction in the grade five one-to-one computing environment is that it was outcome-based. The DIF and classroom teacher believed it was important for everything done in the classroom to include the "why." The DIF explained that instruction was, "Very much solidly tied to those outcomes and included constant assessment, daily."

Constant assessment was a second characteristic of demanding instruction in the grade five learning environment. Assessment designed into instruction included pre-assessments, formative assessments and summative assessments. An example of a pre-assessment used in the one-to-one environment was described by the teacher as using a question prompt in either Moodle, Wiki Spaces or Google Sites to find out what the student may know about a specific topic before covering it. The DIF describes how formative assessment was also accomplished through the use of a Wiki.

> "So they get into their Wiki and they respond to a prompt of some kind, you can instantly see who's got it, who needs it again, who's so far off the mark that we need to take another 360 turn and start over. So the formative assessment, I think has really improved in that way."

An example of summative assessment in the one-to-one computing environment was the final showing or presentation of knowledge relating to the task. The Principal described this through a process where students take an active and engaging role in their learning, having opportunities to make choices.

> "Students taking an active and engaging part into their learning that help them shape what they were learning. How they were going to create their outcome. How they would create their product. Maybe who they would work well with. What their multiple intelligence would be, that they would know that I'm this type of a learner so that I'm going to use this type of technology, or I'm gonna use this type of tool to come up with my answer."

A third characteristic of demanding instruction in the grade five one-to-one environment was that the teacher had high expectations for each student. A student interview transcript described one aspect of teacher expectations resulting in student reading and comprehension.

> "In most other classrooms the teacher would just read everything out to you but now we are learning how to read more. The teacher is saying, "read, it tells you everything you have to do there and every step you need to know." In previous classrooms the teacher would just read it for you and tell you what to do. Now we are learning more what to do."

In another example of expectations, the teacher describes that learning is never done in the classroom. Students digging deeper with their knowledge was often part of the learning process.

> "If we're finished an assignment, it's now I go onto the next step and next lesson and go working through. So we all established, very early in the year that it's

okay to be working on different things at different times, it's okay to be at different levels."

Scaffolded. Tomlinson (2003) distinguished characteristics to scaffold curriculum and instruction. Presented below are instances of scaffolding, within the grade five one-to-one computing environment, which directly relate to Differentiated Instruction (DI) incorporated through the process of instructional design

Evidence of scaffolding curriculum and instruction was *first* represented in how the teacher was provided guidance in teaching diverse learners. The school division supported all teachers, including the grade five educators, with professional development on the UbD process. Additionally, guidance directly related to teaching diverse learners in the one-to-one environment was provided through a one-to-one project support team. One of the key members for supporting the implementation of DI in the grade five learning environment was the local school Differentiated Instructional Facilitator (DIF). Support for instructional design and transforming content to be used in a technology-based learning environment came from Digital Learning Consultant(s) (DLC) supplied by the school division.

Secondly, curriculum and instruction which included scaffolding, embraced clear classroom operations which supported student learning. Findings are represented through the classroom teacher working with the support team, and at times students, to establish classroom rules and norms. Many of the classroom rules and norms were clearly posted on the classroom webpage accessible to students and parents anytime.

Thirdly, scaffolding curriculum and instruction includes a variety of modes to reach varying learners. The following overview provides diverse instructional strategies used to reach varying learners within the one-to-one learning environment.

Instruction designed for the grade five technology-based learning environment took into consideration various student learning styles. The team of educators believed that DI in a technology-based learning environment was natural. The DIF explained how technology provided an opportunity to build scaffolding right into the lesson.

> "Being able to build your scaffolding right within the lesson, so that students can look at it and say well if I need the graphic organizer I go here. If I am okay without the graphic organizer I can go here. If I need to have some pre-writing things done, I'm going to go over there. So students become well-trained in knowing themselves as learners through the technology. So it is quite an amazing transformation that takes place, from the teacher being the one to say you need this, or this, and this. The students are the ones that are saying I'm okay without that today; I'm going to move on and do it this way."

Results indicate that online instruction allowed students to use both visual and auditory modes to pursue problem solving tasks. A student interview transcript shares how audio and video were used by learners. "Some kids are not very good readers, so they can listen to some audio, for some kids they may be able to get more understanding out of a picture or a video, than they may out of just text." Another student interview

transcript describes how flexible instruction helped a grade five student who struggled with reading and writing.

> "One student who maybe has trouble with reading can listen to audio, and he has trouble with spelling and making good stories or sentences, so then he can use the tools on the computer like iSpeech or Fusion and he also watches the videos that the teacher puts up."

Learning tasks supported the flexible expression of student learning through presentations associated with learning styles including: visual/spatial, verbal/linguistic, bodily/kinesthetic and musical/rhythmic. An example of this is provided in the following quote taken from instruction on a task provided to students in the grade five learning environment.

> "Step1: Your first step is to decide on the method in which you would like to present your research findings.
>
> Your presentation method is to be based on one of four learning styles, identified for the purpose of this presentation, including: Visual/Spatial, Verbal/Linguistic, Bodily/Kinesthetic and Musical/Rhythmic. To view more on learning styles click here.
>
> Once you have decided on which learning style you will base your presentation on, you will need to decide on the type of presentation you will create. To view

examples of various types of presentations that you can do, which match your chosen learning style, click here."

Specified criteria for quality work and coaching students in achieving criteria is identified as a *fourth* characteristic for scaffolding curriculum and instruction. Rubrics, identifying criteria for outcomes or tasks, were made available to students in the grade five learning environment through links within online instruction. If needed, resources such as graphic organizers as well as additional resources were accessible to students through instructional online links. Instruction provided to students in a well thought out, step-by-step format was identified by students and educators as a valuable design in achieving learning outcomes. One student interview transcript describes the step-by-step instruction, "Just go into Moodle and it has the step-by-step thing, and then it takes you to different links to learn more about it or you can just research and figure it out." The Principal explains, through their interview transcript, their perception of what stood out in the instruction.

"A piece that really stuck out to me as an administrator would be, as lessons were laid out, students had the opportunity to make choices. And that would be in the area of differentiated instruction."

A *fifth* and final characteristic of scaffolding curriculum and instruction discussed in this research study is learners establishing personal goals and assessing their progress according to criteria. Student goals were determined through completion of smart goal

inventories. Goal progress was then analyzed through pre-assessments, student led-conferences and formative and summative assessments.

Supplemental Analyses

A supplement analyses which arose out of the research study was student independent learning. The educational team in the grade five learning environment stressed the importance for students to become independent learners. As identified in the teacher interview transcript, "…one of my aims is to teach kids independence." Educators believed independent learning to be intrinsic in attaining deeper thinking and building 21st century skills. An example of this comes out of the teacher interview transcript:

> "Intrinsic to all of this is independent learning, is what we're not looking at the teacher all the time for the answer. We have to go inward, we have to collaborate with others, and we have to be able to become deeper thinkers. Because if I can make those kids more independent in their learning there is so much more I can do in building those 21st century skills, because that's intrinsic to building 21st century skill is to build that independence."

Building independent learners took a change in mindset and a great deal of effort and planning by the educators in the grade five learning environment. Mindset, dealt with the teacher realization that students become actively engaged in their own learning, actively participating in the learning process where teachers themselves are not

distributers of all information. Support for this idea is presented through the teacher interview transcript:

> "So I come into that room thinking, "How am I going to build independence for those kids?" And also how can I make my instruction as fluid as possible that all my kids can find success in it so that I can facilitate as much as I can in that classroom? That they don't even need me anymore in a sense, because the instruction can hold its own but where I'm needed is to clarify, to work with those kids, to give those kids one-on-one that I don't usually get to give kids one-on-one in the classroom. So that I think is huge."

Effort and planning coincided with how tasks and instruction were designed and accessible to students to accommodate independent learning. Educators, at the beginning, described the process to student independent learning as something they had to work at. To become independent, students had to continuously be encouraged to read, listen and, view instruction to complete tasks. This is described through the DIF interview transcript in response to how they saw learning in the grade five environments compared to more traditional learning environments.

> "Probably the biggest thing is their independence. And that wasn't magical first day. It was something the classroom teacher and I worked very hard with the students in, encouraging them to go ahead and do the reading. They were used to the sage, coming along, helping them, guiding them, and taking their hand. And

we joke with them about spoon feeding, but that's what they're used to, that's what they think we should be doing."

Data from this study suggests that efforts by educators to cultivate independent learners have produced positive results. Observational data indicated that students were clear in understanding directions and tasks to be completed, were able to follow instructions independently and did not have to ask the teacher "what to do next." As supported through the DIF interview transcript.

"So probably the biggest change I've seen is independence. Where they're able to, for example this morning, some students were finished with a graphic organizer, some students were moving onto the writing stage, and some students were still doing research. So they all went in and knew where they were and what supports that they needed to get that done."

Although sometimes a difficult process, educators in the grade five technology-based learning environment believed that providing learners with well designed instruction led to teacher facilitation and freedom to work more closely with students, deeper student thinking and independent learning. Support of this is provided through the teacher interview transcript.

"And also for teachers if you come into this from a traditional classroom to realize it's not easy, you're not going to get this all at once, it's going to be a huge learning curve. But once you reach the top of the hill you're looking at so much

> freedom because now I have opportunity to build amazing instruction and work with those kids and I know those kids are becoming deeper thinkers, they're becoming independent learners. And they're learning more because of what I'm doing."

Transformation results saw a change in students, as expressed by the DIF, "it's quite an amazing transformation that's taken place, from the teacher being the one to say you need this, you need this, and you need this, the students are the ones that are saying I'm okay without that today, I'm going to move on and do it this way." Teachers in this environment saw themselves as facilitators, working with both individual and groups of students to clarify necessary items and meet the needs of the learners, as the needs arose in real time.

Summary

Chapter Four presented the results of the study organized around each of the research questions. Results were established through the data analysis of interviews transcripts, observations, and documentation.

The *first* research question examined the relationship between three strategies (One-to-One Computing, Instructional Design, and Differentiated Instruction) in the enrichment of learning. Results presented on this question focused on physical space, pedagogy, and curriculum, assessment and instruction.

The *second* research question analyzed instructional processes and pedagogy of technology-based learning. Results of this section focused on how instructional processes and pedagogy transformed in a one-to-one computing environment. Results were organized around themes of technology and instruction, and multiple layers of 21st century skills (core subjects, learning and innovation skills, life and career skills, and information, media and technology).

The *third* research question explored one-to-one computing and instructional design. Results were provided on how instruction was designed in the grade five one-to-one computing environment. Results were organized around topics including characteristics of technology-based instruction and non-technology or traditional instruction.

The *fourth* research question investigated applying learning resources in a one-to-one computing environment. Results related to processes and circumstances contributing to technology-based resources used in the grade five learning environment. Results were presented among three categories including: teacher deliberately designed instructional resources, student initiated resources and student unique learning resources.

The *fifth* and final question researched differentiating instruction in a grade five one-to-one computing environment. Results were presented on process of how instruction was differentiated in the grade five technology-based learning environment. Results for this question were organized around Five Characteristics of Effective

Instruction (Tomlinson, 2003) including curriculum that is: important, outcome-based, engaging, demanding, and scaffolded.

A supplemental analysis concludes the results chapter. The supplemental analysis presented findings that arose out of the research regarding student independent learning. Chapter Five presents further discussion and interpretation of the research study results.

Chapter 5
Discussion, Conclusion, Implications & Recommendations

Chapter five provides further discussion on the results of the research. This chapter is organized to interpret and discuss each research question individually. Comments and reflections of compelling phenomenon have been included by the researcher. A conclusion focuses on the questions of the research, followed by implications of the research and recommendations.

Interpretation of Each Result

Discussion – Significant enrichment effect of each variable. Results of this study identify how intertwined strategies including one-to-one computing, instructional design and differentiated instruction facilitated the enrichment of teaching and learning in a grade five class to accommodate acquisition of 21st century skills. We not only see these strategies overlap in many areas but realize individual strengths and supportive natures of each in the enrichment of teaching and learning.

Physical Space. Throughout the design of the physical space, the three strategies appeared to either imbricate or complement one another. It is believed the replacing of traditional classroom desks with tables to create learning pods had numerous implications. First, students were not able to come into the classroom claiming a space, in terms of a desk, as in traditional classrooms. This eventually led to members of the classroom (including the teacher) being more open to movement, which was useful for

creating flexible groupings. This attempt at creating a less rigid and more fluid classroom fostered student movement, comfort, self-regulation, collaboration and communication. An informant comment regarding classroom management, explained the teacher could have set up pods and still ran the classroom very traditionally. However, the teacher chose to "allow the students some freedom to make good choices" relating to movement throughout the classroom and where they situated themselves in the classroom. The classroom teacher provided further explanation through a quote from their interview transcript.

> "RTI has also been adopted this year in my classroom, so I've really learned to allow the children the chance to work wherever they feel they need to in the classroom. So kids will be working standing up at a table at the back or they may be underneath a table, on the floor, depending where they feel most comfortable. So the way the classroom has become it's very, very much a fluid classroom, it's not rigid. There is a lot of opportunity for them to move around."

The size and space the pods (tables) offered were considered to be more accommodating of the netbooks and allowed for students to share netbook screens more efficiently. Students indicated that the design of the space made them more open to asking questions, supportive and collaborative with each other while using their netbook and accessing resources. The following student interview statement supports this finding:

> "Previous classrooms you cannot ask and collaborate that much because you have one desk with no one right beside you. But in our classroom there are usually two or more people at a table, so you always have somebody to help you and to ask."

Inviting the division Occupational Therapist (OT) into the one-to-one learning environment proved to be beneficial in "raising awareness of using proper posture and taking regular "microbreaks" when using the netbooks because the design of netbooks create great challenge to modify and construct good ergonomic work environment" (So, 2010). The division OT presented to teachers and students that netbooks violate basic ergonomic design requirements due to the screen and keyboards being connected as one unit and cannot be positioned appropriately for viewing and typing (So, 2010). To help this challenge, the OT provided useful information such as paying attention to posture and taking regular breaks to help reduce strain on muscles and joints, and prevent injuries related to computer use (So, 2010). Recommendations related to netbooks, chairs, body posture, body position, visual suggestions, and exercises for various parts of the body were provided.

Although it took time for the teacher to become comfortable with softer lighting in the classroom, students found it provided a much more relaxing atmosphere. The teacher commented that she did eventually find it more relaxing and found that kids did not suffer or complain about headaches as often compared to when using overhead fluorescent lighting.

The addition of netbook storage and charging carts, identifying class time plug-in locations and mounting a 32" LCD allowed for new structures and organization within the learning environment. Students were clearly provided with rules and expectations on how netbooks were to be used and maintained.

The classroom teacher and DI facilitator identified the importance of the design and setup of the physical learning environment for implementing various strategies, especially those dealing with one-to-one computing, technology-based learning and DI. The physical space and tools available in the learning environment were said to lend themselves to offer better opportunities for 21st century learning and skill building. As supported in the DI interview transcript, "I do think that the learning and innovation skills, the critical thinking, problem-solving, communication, collaboration, creativity, those just come much more naturally in this environment." It has also been discussed that the design and setup of this learning environment resulted in the classroom teacher describing the environment as one that says 'let's learn' opposed to 'teach me.'

Pedagogy. Educators in this learning environment, including both the classroom teacher and DI facilitator, have identified how their approach to pedagogy changed. Two concepts consistently emerge when analyzing data related to change of pedagogy. The first is the idea of transforming from direct teaching to facilitation. The classroom teacher describes the transformation of teaching in this type of learning environment as "scary."

> "I was very comfortable teaching in a very traditional way. I thought it would be easy for me just to let go of my old pedagogy and just embrace this new way of teaching. But the reality is it's scary, it's new, it is something where when you begin you're questioning whether what you're doing is right, is it benefiting the kids? Am I doing any damage to these little people if I'm changing my pedagogy like this?"

Interview and observation transcripts from both the Principal and Differentiated Instructional Facilitator (DIF) described the classroom teacher moving towards a more open type of teaching, more student-centred, student directed and student network-based. Students often chose how they wanted to go about completing projects, through the use of technology, or more traditional mediums of paper and pen. This has been interpreted as a pedagogical change, from the teacher having security in what the students are doing, to allowing them to make good choices and show what they are able to do. The classroom teacher is described by school Principal as "guiding, really being a facilitator, and the students taking an active and engaging part into their learning that help them shape what they are learning."

This leads to the second emerging concept, 'letting go.' This is a concept that is thrown around quite liberally when describing the transformation from traditional teaching to technology-based learning. It appears there are many interpretations of the term 'letting go.' However, a summary is provided from the educator's perspective of the grade five learning environment researched.

The characterization of 'letting go' came about as educators involved with the grade five learning environment were not comfortable with the idea of 'just letting go'…a process in which you let the students' lead the learning. They believed this provided somewhat of a misleading representation of the concept. In its true form 'letting go' is quite complex and involves items recently discussed including change of pedagogy, flexibility and facilitation. It also contains items such as *organization*, *humility* and *trust*. These terms are explained in more detail below.

In contradiction to the true meaning of the term 'letting go', educators within the one-to-one learning environment disclosed they have never been so *organized* with the planning of their lessons. In order to plan in a learning environment that 'let's go', instruction looks much different in both design and access. Instruction, in this environment, is based on curriculum, very structured and well thought-out, and conveyed step-by-step; incorporating a variety of strategies and tools to help students learn. Instruction is designed for facilitation opposed to direct teaching; allowing teachers more time to help students in need. Students have the ability to access the instruction in groups or individually from any location with Internet access.

Traditionally, teachers have been described as 'distributors' of knowledge. Teachers in the grade five learning environment were unfamiliar and uncomfortable with the perception of not knowing all the answers and not being able to immediately produce correct responses to student questions. The teacher communicated, through the following

interview transcript quote, that they were not accustomed to admitting to students that they did not have the answers or did not know.

> "I thought I needed to know everything. I wanted to be the one that said okay we're doing it like this or, you know, having a bit of a control issue perhaps, with what was going on. And that's the other skill I think, is to be able to release that. To not let go to pure chaos, to let go of I'm the one that's making the decisions. I will decide what the outcome is and what the assessment will be, but you can decide how you show me that you've got it."

This is where humility became part of the formula. Teachers in the technology-based learning environment often delivered reserved looks in response to student questions. Teachers became comfortable with admitting they did not know and suggesting that together they find a way to complete the task. Teachers quickly realized they had no choice but to allow students flexibility in how they went about solving their problems. Some students worked through problems on their own, while others asked peers to help solve problems. Students were allowed the opportunity, often with the teacher learning alongside, to recognize there are many ways to find the answers to the question they were searching. Initially, teachers found their new combined role as instructional designer, facilitator, and learner difficult. However the new combined role has allowed the teacher opportunity to focus on learner needs, learning styles, assessment, and supports required to create the best learning environment for each and every student (Farley, 2010).

Trust is the third item relating to 'letting go.' The trust and support of the school Principal was essential. Teachers in the grade five one-to-one environment knew they had the backing of their Principal which was required for them to feel comfortable with risk taking and change. The school Principal identified it was necessary to have supports in place for the teacher, "You need people that can be supportive of the teacher, such as our technology consultants have been." The Principal believed the 'big step' or move towards technology-based pedagogy "…could be very intimidating, but when you have supports behind you, I believe that you're more willing to take the risk." The school Principal also identified the importance of support from the school division.

> "I think that you need an environment in which they allow you to take risks. Such as our school division has done in allowing this opportunity to happen for our teachers and students and consultants and so on. We've been able to take a risk to see what it can really do. It may have gone a different way. It went in a very positive way. And I think that that risk has been very beneficial."

Educators in this learning environment trusted the change in their pedagogy and that the change was good. At times, students, parents and even colleagues questioned aspects of the learning environment. However, the educators trusted their motives and desire to transform teaching and learning and had support and guidance when necessary.

> "So what skills does a teacher need if they're going to embrace this new pedagogy, is to realize you're embracing a new pedagogy. That you are going to

> see changes in the way you teach and that's okay. That it's okay to realize the kids have skills that are going to be far more than what you have and that they can teach you different things. And that to me was probably the biggest eye opener is that I designed the instruction, I need to design the instruction in a way that's engaging, that allows kids to prompt themselves to be creative, to communicate, to collaborate. I need to design the instruction that way and I needed to be very organized and very detailed."

Trusting that students have skills or can learn necessary skills to be successful in this type of learning environment was another realization by the educators. As identified through the following teacher interview transcript.

> "Where my learning came was with the kids, how much they could take that and go places where I never even knew that they could go. And I needed to be okay with that, I needed to be okay with the kid who the task was to convince me that we needed to have the computers, the Internet in our classroom, to come to me and say, "I'm using a DSI", and for me not to have any clue what the DSI would do. And I didn't need to know what the DSI could do, but all I needed to know was did they hit those outcomes? Were you persuasive? That's what I needed. The kid said, "Yes, I am". "Well, then go show me", and they did."

Curriculum, Assessment and Instruction. A speculation for the grade five one-to-one learning environment would be for its natural focus to be on technology.

Although, technology appeared to provide greater opportunity in meeting student need and engagement, analysis reinforces the idea that the focus was on curriculum, assessment and instruction. As indicated by the DIF interview transcript.

> "Know your outcomes, understanding why you're doing it. That I would say is integral in looking at this environment and in the planning. Because you can get kind of bogged down with, oh here's a cool website and here's a cool little thing that I could throw in there just for fun. But continuing to go back to the why, why am I doing this and what is the outcome for the students."

A great deal of effort and time was put into the design of lessons or tasks by educators, including the classroom teacher, DI facilitator and DLC. Tasks were organized around learning and design strategies including DI, RTI, UbB, ID, one-to-one computing and technology-based learning. Through the in-depth planning and design of various strategies into lessons, student learning transpired through a broad scope of multimedia including text, audio and video. Importantly, students accessing one-to-one computing allowed for instruction to be designed and presented through a variety of multimedia, much different from a traditional, non-technology-based classroom.

Discussion - Instructional Processes and Pedagogy of Technology-Based Learning. The grade five classroom teacher describes her former instructional processes as focused on tools when teaching with technology. An example describes prior methods, as to how the grade five teacher taught media literacy, compared to more recent methodologies. Previously, media literacy would be taught through concepts of digital

storytelling using computer applications such as Windows Movie Maker. A focus would be on using Windows Movie Maker to create a digital story relating to the task. Students were required to use the software application to complete the task. The teacher believes a more effective instructional process is to focus on learning outcomes and allow flexibility to students in the processes they use to present their knowledge. Instruction using this method focused on cross curricular outcomes associated with the task. One such task centred on a theme of cyberbullying (meeting multiple learning outcomes in both ELA and Health). Students were required to research and present their findings on cyberbullying. Students were instructed to present their findings through some form of digital multimedia however, tools and presentation format was left for individual students to decide. The goal of the instructional process was to focus on learning outcomes and use technology to enrich flexible student learning experiences.

Instruction in the grade five technology-based learning environment was presented through Moodle to provide student access anywhere with an Internet connection. The classroom teacher found that designing instruction in Moodle beneficial, due to the fact it could be done from any location with Internet access. Further benefits in using Moodle were identified as being able to make use of digital and web-based resources, including multimedia into instruction, having assessment and feedback embedded into the LMS, freeing up time for the teacher to facilitate, more time to work with individual students or small groups, and direct students back on task.

As a result of the one-to-one computing environment, web-based resources became a useful process the classroom teacher adopted to convey instruction to students. A classroom wiki, for example, functioned as the virtual hub of the online classroom, including links to class norms, subjects in Moodle, activities in Google Sites and various online surveys. The Wiki also became the tool used for the online classroom discussion area. The classroom teacher would post a discussion question or prompt every day on a relevant topic and students would post their discussions throughout the day. This process appeared to be very engaging for students resulting in 3684 discussion posts, mainly by students, throughout the school year (September to June).

Wiki prompts were realized as a useful formative assessment tool in the grade five technology-based learning environment. Wiki prompts provided instant feedback when checking for student understanding as described in the following blog post by the DIF.

> "Students quickly respond to a focus question, generally checking of "what stuck" from a previous lesson. Instantly, it can be seen which students have gained an understanding and to what degree. Also apparent are those who really did not understand the lesson or who may have been absent and missed the lesson entirely. This information is very valuable for grouping students for re-teaching, reinforcing, practicing or extending the lesson. The feedback has also been used as a reflective tool in helping the teacher recognize what part or parts of a lesson may not have been clearly taught. Students are comfortable with the Wiki space

format and are not bogged down with spelling or grammar as "informal language" is accepted in this space. This allows students to respond in a timely but honest way. Students are working on expressing their understanding with depth and clarity so there is little room for misguiding the instruction. In this format, student responses are a good indicator of the level of understanding gained and show another way that Wikis work!"

Google Apps including Google Docs and Sites was one of the processes used to deliver instruction and enhance collaboration in the technology-based learning environment. Grade five educators found Google Docs useful in group brainstorming sessions, in-class group assignments and distant activities with outside classes (e.g. grade five students from neighboring community). A way in which Google Docs was used is the teacher would set up one document in Google Docs and share the document with students in the class. Each student used their netbook to access the teacher's shared document and type their ideas into the document. This resulted in one collaborative document with all the students' ideas viewable and projected on the large screen for group discussion.

Google Sites was another tool used by the classroom teacher to deliver outcome based instruction to grade five students. An example describes a student task, based on a theme of Internet Safety & Information Privacy, developed in Google Sites. Once designed in Google sites the task was accessed by each student using their netbooks.

Google Sites was also the process used to create grade five student e-portfolios. One-to-one computing allowed opportunity for each student to create distinctive e-portfolios within Google Sites. The e-portfolios were effective and appreciated when students shared them with parents during student led conferences.

Skype, an online communication tool, was used for synchronous distant activities with outside students and teachers. To first design distant activities, the grade five teacher would connect with the neighboring community classroom teacher through Skype. This allowed the two teachers to effectively collaborate, without traveling to each other's community, throughout design stages of the activity at a distance through audio, video, and screen sharing. Instructional content, of the activity, was designed into either Moodle or Google Sites. Students were then able to use their netbooks to access instruction on the Internet. The two classroom teachers organized sections of the activity each would facilitate. Skype was then used to communicate and collaborate on the activity between the two classes 'live' or synchronously.

The grade five classroom teacher identified a document camera as one of the 'must have' instructional tools for a technology-based learning environment. It has been used in the grade five learning environment to analyze hand-written text, focus on text structures as a group and use meta-cognition to explain thinking when solving math problems. A drawing feature allows text structure to be circled and highlighted all while being projected on the large screen to focus students' attention. Students also made use

of the document camera during class presentations of hand-produced items including posters, drawings and diagrams.

Discussion - One-to-One Computing & Instructional Design. Instructional design was seen as one of the main cogs in delivering effective instruction to the grade five technology-based learning environment, as identified by the classroom teacher through the following blog post.

> "When I first started teaching in a 1:1 computing classroom, I thought the tool of the netbook would drive instruction. Instruction would revolve around teaching applications and having the students create cool projects that would prove, without a doubt, that my students would be well versed in 21 century skills. I quickly realized, however, that the netbook is just a tool and that sound instruction, which relies fundamentally on curricular outcomes, is truly what drives instruction. As the year has progressed, I have come to understand the importance of creating effective instructional design in order to truly facilitate learning. I also learned very quickly the importance of starting to create online instructional design on a small scale."

Instruction designed in Moodle, Google Sites and Wikis followed a very step-by-step process. The teacher transcript explains that initially, lessons were provided as traditional content transferred to Moodle but changed to a problem-solving, inquiry approach organized around the following structure:

- List of curriculum outcomes
- Problem Statement
- Task required to solve problem
- Steps required to solve problem
- Solution or Findings

An item which stood out for students, relating to the design of instruction, is the detail put into step-by-step instructions. One student identified their experience in previous classrooms as teachers reading everything and telling them what to do. In this grade five classroom, when available in suggested formats, the teacher urged students to read, listen or view instructions because it identified what they needed to do in order to complete tasks. Another student described how instructions in Moodle helped "because if you don't want to ask the teacher, you can go into Moodle for instructions instead of just sitting there and get right to work." A third student commented "it is better than having the teacher talk and write on the board, so you can read it over if you miss anything."

Two models, believed by the researcher to have similar philosophies, were used in the instructional design process. First UbD was adopted by educators to look at curriculum, unpack outcomes, and identify assessment (rubric or performance). The results of the UbD process was used to design what instructional designers' term a 'blueprint.' The ADDIE model, a systematic instructional design model (Learning

Theories, 2008), was then employed to integrate technology and transform the instruction to be used in a technology-based learning environment.

A summary of the five phases of the ADDIE model is provided below (Learning Theories, 2008).

Analysis

- During analysis, the designer identifies the learning problem, the goals and objectives, the audience's needs, existing knowledge, and any other relevant characteristics. Analysis also considers the learning environment, any constraints, the delivery options, and the timeline for the project.

Design

- A systematic process of specifying learning objectives. Detailed storyboards and prototypes are often made, and the look and feel, graphic design, user-interface and content is determined here.

Development

- The actual creation (production) of the content and learning materials based on the Design phase.

Implementation

- During implementation, the plan is put into action and a procedure for training the learner and teacher is developed. Materials are delivered or distributed to the student group. After delivery, the effectiveness of the training materials is evaluated.

Evaluation

- This phase consists of (1) formative and (2) summative evaluation. Formative evaluation is present in each stage of the ADDIE process. Summative evaluation consists of tests designed for criterion-related referenced items and providing opportunities for feedback from the users. Revisions are made as necessary."

Teachers identified the stage of incorporating technology into instruction as the most overwhelming. This coincides with an observation made by the researcher, stating most teachers are experienced and comfortable when designing curriculum and instruction for *traditional* learning environments. However, when they are asked to design curriculum and instruction for *technology-based* environments, they may hit a road block by not fully understanding what is being asked of them. As a result supports may be necessary for teachers to be successful in transforming from traditional to technology-based pedagogy.

The grade five classroom teacher identified supports including Digital Learning Consultants helpful for understanding the design of instruction used in technology-based learning environments. A hypothesis is that, along with good teaching, supports in curriculum and instructional design were important elements in making the grade five one-to-one initiative successful. It is questionable if the initiative would have seen such wide spread adoption without significant supports. A speculated support strategy, similar to the one used for grade five one-to-one computing initiative, is a classroom teacher, Differentiated Instructional Facilitator and Digital Learning Consultant. The team would work collaboratively to create models of instruction designed for technology-based learning.

Discussion - Applying Learning Resources in a One-to-One Computing Environment. Technology-based resources, deliberately designed into instruction, were identified by both teachers and students as supporting different learning styles and potentially allowing for deeper understanding. The following quote from the teacher interview transcript further explains this notion.

> "The most important realization for me has been just how much more learning happens in the classroom by having a technology based classroom. I know my kids have learned more. I know they are deeper thinkers. I know they are better problem solvers. I know they are more creative in how they approach different things. They are engaged in my classroom, they are empowered in my classroom. My kids have learned so much. And for me to be a part of that and to have a

small part in that whole process has been phenomenal for me, it just has been an eye opening experience."

When educators included a variety of technology-based resources in their instruction students were able to choose resources that best met their learning style. As the grade five teacher explains, "I've incorporated differentiation in the way of sound recordings so kids who struggle as readers can listen to the instructions, screen captures, using Jing, using different things like that so the kids can follow and become independent." Often multimedia resources were included to supplement text-based instruction. Some of which included YouTube, audio clips, flash games and instructional videos created with screen capture/recording applications. Interview and observational transcripts identified two successful strategies used in the grade five one-to-one learning environment as adding audio and visual support to online instruction. The process of implementing audio support into online instruction had the teacher read and record the instructions using a web-based audio recorder such as Audioboo. Once recorded, the audio recording, of the teacher's voice reading the instructions, was embedded into Moodle or Google Sites to supplement text based instruction. A second strategy included adding visual support for students into online instruction. This strategy had the teacher use a web-based screen capture application called Jing to capture screen images, and voice explaining instructional processes. The instructional video was then uploaded to a video host like YouTube and embedded into Moodle or Google Sites to enhance instruction.

Although further research is necessary, transcript analysis in the grade five learning environment supports students using 21st century learning and innovation skills such as creativity, critical thinking and problem solving. As described by the teacher, "Learning and innovation skills, the four C's, the critical thinking, the communication, the collaboration and the creativity I think are really well linked to instruction using technology, very easy to have problem based learning." It is possible that flexibility designed into instruction, including the problem solving approach and adding visual and audio supports, allowed for individual students to initiate the use of various learning resources resulting in development of student learning and innovation skills.

An example of a learning task describing a student-initiated resource is when students had to come up with a persuasive presentation on how they would safely use the Internet. The task allowed students to choose how they would research, design, develop and present their findings. Most students used a variety of resources familiar to the teacher, however, one student asked to use a Nintendo DSi (handheld game system) to complete the task. Although unfamiliar with the tool, the teacher allowed the student to use the DSi for the presentation as long as outcomes were met. The student created an engaging persuasive presentation through the DSi meeting curriculum outcomes.

To assist one student in a unique learning situation with writing, a Fusion Writer was introduced. The Fusion Writer supplied several supports for writing including word prediction, speaking function and transferred text directly to a Word document. Word prediction helped the student with words they could recognize and select from a list of

possible word choices. In situations where the student did not recognize the spelling of a word, the student used the speak function. This function spoke the typed text in the way it was written for the student to hear. If a word was misspelled, the student heard it pronounced wrong and went about correcting it. The Fusion Writer is capable of transferring content on its screen directly into MS Word. In another unique situation, free online Text to Speech (TTS) voice software called iSpeech® was used to help with reading and writing. Students went to the website www.ispeech.org and either typed in text or copied and pasted text into the text box and the TTS software read back the text through audio in a considerably natural sounding voice.

Discussion – Differentiating Instruction in a 1:1 Environment. Further discussion and interpretation of results relating to DI management strategies and instructional design of DI into the one-to-one learning environment is provided below.

DI strategies such as flexible grouping and peer teaching are identified by the teacher, DI and Principal as some of the management processes used in the grade five learning environment to support student learning. As described in the teacher interview transcript, "As the day goes on depending on flexible groupings what we have arranged in the classroom, it's a very fluid classroom moving around doing different things in different areas." The Principal alludes to peer teaching when discussing students, "working with other students have to take that leadership role and they did take that leadership role." The DIF describes flexible grouping and peer teaching through the following interview transcript.

> "I would say that the biggest thing I've noticed is, with sitting at tables, the students have become much more collaborative. So they are more likely to ask somebody at their pod for assistance or help in an area, or lean over and provide that assistance to someone else. It's a more open environment, so if they feel the need to pick up their net book and move over to another group, it's much more flexible that way. And there's a lot more acceptance of other people's needs. So if I'm a person who needs to sit on a stool then I can do that. If I'm a person who needs to stand at a table at the back, it's more accepted because there are lots of different things going on all the time. "

In the past students who struggle in areas such as reading often required either someone coming in to help or the student leaving the classroom for support. Educators within the grade five classroom believed student segregation has been reduced through the collaborative results of flexible grouping. Students appear to be collaborating more and under the circumstance helping each other a great deal known as peer-to-peer teaching and learning. This is supported through a quote from the teacher interview transcript.

> "When it comes to differentiation oftentimes we feel as a teacher, or I felt as a teacher that I had two or three kids that couldn't read, therefore, I needed to have help in the area of a DI person or a DET coming in and helping with those individuals, or looking at pulling out as a solution to helping kids who struggle

academically. But what I've found in a collaborative classroom is that oftentimes the kids are helping each other, these flexible groupings. It's so that we have a different range of learners based on an interest or learning profile working together as opposed to segregating the kids that are not learning so are not learning as fast or having challenges in certain areas.

And I believe what that has given kids is, I think, so much more of an ability to learn, opportunity learn. But it also has built respect amongst students. We're all not the same and you may have strength in one area, but I have strength in another area. And what I found in my group is that there really has been a building of respect between students that may not have had the opportunity to work together before and just judged one another from what they perceive in getting on tests or feedback that the teacher has given them in the past."

A DI strategy termed 'traffic lights' has been renamed '3D traffic lights' and incorporated into the grade five learning environment. 3D traffic lights consist of each student having three plastic cups (red, yellow and green). If the student is struggling or has a question with a task he/she displays the red cup. The red cup provides the teacher with a visual to identify the student requires immediate assistance. The student displaying a yellow cup represents a student who has a question but can still continue on with the task. A green cup, displayed by the student, represents the student is fully able to independently complete the task. This strategy resulted in students understanding how to get help when the teacher was busy with another student or group (Tomlinson, 2001).

The CEA report (Willms, Friesen, & Milton, 2009) associates student engagement with student learning climate and student confidence levels. Educators in the grade five learning environment, similar to the CEA report, identified student self-esteem and self-confidence as important characteristics to consider for student success. It was identified, through the teacher interview transcript that a particular student in the grade five learning environment suffered academically due to low reading and writing skills. However, when provided a netbook, the student displayed strong technology and problem solving skills. The student indicated through their interview transcript that they found technology-based tools and resources useful to assist with their struggling academic areas and was also able to assist with solving many classmates' technology issues. The teacher interview transcript identifies, as a result the student's self-esteem and respect from peers increased, leading to better interactions with people and fewer problems on the playground. At the end of the school year, in June, the student saw their reading level rise from 1.4 to 3.9. Although this research did not analyze or focus on reading level changes, it is believed self-esteem and self-confidence may have helped the increase.

Discussion – Address Important Curriculum & Focused on Outcomes. The discussion will now focus on interpreting characteristics of effective instruction which address curriculum outcomes, engagement, challenge and scaffolding. Results will be analyzed through processes of instructional design, which incorporate DI into instructional content.

Identified in the educational team interview transcripts including the teacher, DIF and Principal, the process of planning and designing instruction to incorporate DI strategies for the grade five one-to-one computing environment was not an easy task and, therefore, required a team approach, differentiating at a comfortable pace for the teacher. The teacher and DIF first met to review curriculum and unpack outcomes through the UbD process. Tasks were then created, which were aligned to learning outcomes and differentiated (e.g. addition of audio and video supports). The DLC then assisted, through the ADDIE approach, with adapting instructional content to better implement digital resources and DI through technology-based learning.

Engaging instruction designed for a technology-rich learning environment provided an opportunity to accommodate a much different architecture compared to more traditional learning environments. As mentioned in the Chapter Four results, instruction was designed to be accessed by students online through Moodle and students enjoyed the change from traditional paper and pen to working with netbooks. Providing online access to instruction was seen by the team of educators as a DI strategy, building flexibility for students to review instruction multiple times, at their own pace, without always having to rely on the teacher. The DIF interview transcript suggests that the majority of students in the grade five classroom did not want to ask for instruction, look different or stand out.

> "So to have those supports that are available to kids, that they don't have to ask for it, because if they have to ask for it they're not going to. They don't want to look different, they don't want to stand out. It's just built in. And students will

differentiate that for themselves. Some of the time the student that you think would get that support or access that support, might not. And be fine. And the student who you think doesn't need it, is the one that's using it and seems to need it. So I think that's one of the nicest things about technology."

Initially instructional content incorporating DI strategies was provided through a separate instructional path, supplementary to the lesson. The DIF, through a blog post, describes how DI was first designed into instruction.

"A student may choose to read the selection or follow along while listening to a recorded version of the same selection. Responses to the selection can be done through written word or spoken and recorded. We initially looked at having a differentiated way to complete the task as supplementary to the lesson. Then, after observation and discussion, we recognized the merit of having two ways available for all students to complete the same assignment and therefore attend to the same outcome. This way, all students have the opportunity to complete the task in the way they choose. We feel that this way will allow for less alienation of those who feel they need the support. This might also provide some comfort to the students who need the support but choose to "save face" by struggling through the task without support."

Task design in the one-to-one learning environment ultimately made an effort to follow instructional models suggesting effective learning environments, which are

problem-centred and involve distinct learning phases including: activation of prior experience, demonstration of skills, application of skills, and integration of skills into real-world activities (Merrill, 2002). Tasks promoted student learning by engaging students through some form of real world problem, relevant to students in the real world. The following is an example of a real world problem that presented to the grade five students.

> "After an emergency meeting of your school's parent council, the parents of your school have banned the use of the Internet in the classroom! After a unanimous vote to put a hold on all Internet activities, the parents of your school vow that they will never again allow their students to be put in danger by giving them access to the Internet. These parents believe that the Internet is nothing more than an unsafe playground. After much pleading for the students by your teacher, the parents have agreed to meet again next week for a final vote. Will the Internet be banned forever? Or can the grade 5 students change their future."

Tasks were presented as whole tasks as opposed to small components of the task. Whole tasks lead to larger cross curricular tasks meeting multiple learning outcomes. Whole tasks were organized to include, what Merrill (2002) identifies as, four levels of instruction including: the problem-level, task-level required to solve the problem, operation-level that comprise the tasks and action-level that comprise the operations.

A successful, engaging method used to activate students' prior experience was for the classroom teacher to post a discussion question on a Wiki. This was at times used as a pre-assessment tool, helping to activate prior knowledge and recall previous experiences to identify where the student currently is with their knowledge. This directly related to a DI strategy which meets the students where they are (Tomlinson, 2001).

Instruction, in the technology-based learning environment, demonstrated what was to be learned through text, audio and video and then organized and delivered through online instruction. Audio supplemented text when telling information about what was to be learned and audio was recorded with applications such as Sound Recorder, Audacity and Audio Boo. Video was useful for demonstrating examples and non-examples, procedures, processes and concepts. Video included screen casts through Jing, video recording using Flip Cameras and video resources from sources such as YouTube and Teacher Tube. These multi- modes of instruction allowed for differentiated instruction to meet the needs of various learning styles and at different levels of learning. Students expressed their appreciation for being able to access instruction through alternative forms such as multi-media.

As both DI and instructional design models emphasize the importance of being involved in doing real-world tasks, learning was promoted when students were required to apply their new knowledge or skill to solve problems (Merrill, 2002). Tasks designed for the grade five learning environment promoted learning through directly linking application and practice to outcomes. Efforts were made to design tasks directed at

higher levels of thinking so application and practice result in higher order thinking skills such as creating, evaluating, analyzing and applying. Supports of tasks directed at higher levels of thinking are captured in the student tasks using verbs located in the higher levels of Blooms Digital Taxonomy (Churches, 2009) such as create, reflect, collaborate, and analyze. Although not measured, it is believed demanding instruction has been designed through the problem-solving approach. Educators' interview transcripts indicate a personal belief that students are now deeper thinkers, better problem-solvers, more creative and have learned more in the technology-based learning environment.

Characteristics of scaffolding curriculum and instruction in the grade five learning environment are discussed below. Results of scaffolding curriculum and instruction is interpreted relating to classroom operations, variety of modes to meet varying learners, specified criteria and coaching to achieve criteria, and learner goals and assessing personal progress.

As a result of the grade five initiative being the first attempt at one-to-one computing for the school and school division, criteria for classroom operation was unknown and many new rules and regulations were necessary. Initially, time was dedicated to designing the space, functionality of the environment and how netbooks would be used and stored in the classroom. However, much was learned through experiences within the environment. An example of flexibility and teaching within the moment was the need for a lesson on Internet safety, privacy and etiquette resulting from questionable Internet usage by some grade five students.

In an attempt to provide instruction through a variety of modes, to meet the needs of varying learners, instructional design focused on different student learning styles. Characteristics of online instruction and problem-based learning were identified as two effective and flexible approaches to support differences in student learning. Online instruction often included text, audio or video to provide flexibility in learning for those students who may prefer specific learning styles including auditory or visual learning. Supports, for learners, were designed into instruction through text, audio, screen captures and instructional videos.

Student comments suggested that online instructions were well laid out and easy to understand. As expressed in one student's statement, "step-by-step on how you do it, kind of like the teacher telling you what to do and where to go." In situations where students did not understand, they were often given choices to re-read, possibly listen to instructions through audio, view an instructional video, or ask the teacher or another student for assistance. Choices were provided for students to use either teacher or student identified resources to find solutions to their problems. When participating in a collaborative task with a distant group located in a neighboring community, students were able to Skype distant group members for support. As mentioned earlier, one student with difficulties in reading and writing accessed audio and video supports regularly to assistance with translation and comprehension.

A previously mentioned instructional design strategy that also provided DI was the use of rubrics, graphic organizers and additional resources provided to students

through links built into instruction. This process allowed the classroom teacher to create and strategically place all necessary resources into instruction. Students could then access resources as needed.

Goals were established by each student completing a smart goal inventory where academic challenges and strengths were identified. Through established academic challenges a goal was created which students worked on for the year. If academic goals were achieved further goals were identified. Student progress was determined through a pre-assessment which established student baseline knowledge. Progress throughout the year was determined through both formative and summative assessments designed into online tasks. Assessing progress was also done during student-led conferences where the team consisting of the student, parent and teacher discussed supports necessary for the student to achieve his/her goal. Student led conferences provided students the opportunity to use their netbooks and show their parents various task solutions presented in a variety of new media including digital documents, digital pictures, audio recordings and videos.

Conclusion

This research study focused on instructional and learning processes used in a grade five learning environment incorporating strategies of one-to-one computing, instructional design (ID) and differentiated instruction (DI). The study consisted of one main research question followed by four sub-questions identified as:

Main question:

- This research does not hypothesize, however, speculates there is no correlation (do not share variance) between one-to-one computing (1:1), instructional design (ID), and differentiated instruction (DI). Keeping the speculation in mind, what is the significant enrichment effect each of the three variables, under investigation, has on a grade five learning environment for the development of 21st century skills?

Sub-questions:

- How do *instructional processes and pedagogy* differ in a technology-based learning environment in contrast to traditional learning environments?
- What can we learn about the *design of instruction* in a one-to-one computing environment as compared to traditional classroom-based learning environments?
- What is the *process of instructional design* regarding *learning resources* as they are utilized through one-to-one computing environments?
- How can *instruction be designed* in a one-to-one environment incorporating *differentiated instruction*?

The research used the case study approach to gather and analyze qualitative data. Data was gathered through methods including interviews, observations and documentation (blogs). Qualitative data was coded into Nvivo9™ to categorize into themes for analysis of study results.

Through the data gathered and analysis of the data, this research study produced significant evidence to answer each of the questions identified. The conclusion will focus on the analysis of each of the research questions.

The analysis of the main research question concluded that, although no direct relationship is speculated, there are reciprocal relationships to one-to-one computing, instructional design (ID), and differentiated instruction (DI) in the enrichment of learning for the development of 21st century skills. The research has shown that some characteristics of the strategies are intertwined (e.g. one-to-one computers naturally providing aspects of DI) but also complement each other towards the enrichment of a 21st century learning environment (e.g. ability to meet the needs of different learning styles using multiple forms of media, through technology-based learning).

The design and setup of the physical space was identified as an important aspect for implementing the three variables (one-to-one, ID, DI). Replacing the tables with pods produced better space for working with netbooks, collaborating, sharing, movement, flexible groupings, self-regulation, communication, and overall allowed for a more flexible learning environment.

Transformation of teacher pedagogy as accepting and resilient to change was necessary for incorporating the three variables into the grade five learning environment. Teacher pedagogy moved from direct delivery to facilitating learning characterized by the term 'letting go' encompassing pedagogy (technology-based), flexibility (student

choice), facilitation, organization (well-planned instruction), humility (not having all the answers and learning alongside students), and trust (supports of admin and team, and student abilities).

The grade five learning environment incorporating one-to-one computing, ID, and DI identified curriculum, assessment and instruction as the key to success. The focus on curriculum, assessment, and instruction was achieved through the UbD process.

The concluded analysis of the second questions, a sub-question, provides evidence that pedagogical processes have some similarities but also differ when comparing traditional pedagogy to technology-based pedagogy leading towards 21st century teaching and learning. Similarly, traditional and technology-based pedagogy can meet the 21st century skill layers including: core subjects, learning and innovation, and life and career skills. However, only through technology-based pedagogy can the layer of information, media and technology skills be met. Therefore, in question is the ability for up-to-date skills to be met within all layers without a holistic technology-based pedagogy. For example, is it possible to provide a student with the necessary life and career skills they will require in the 21st century through traditional pedagogy and *not* using technology-based pedagogy?

It is also understood that learning skills including core subjects, learning and innovation, and life and career skills, through technology-based pedagogy provides engaging strategies for different learning styles. Some of the engaging strategies

included online access to instruction, gathering and using immediate feedback on students' understanding, responsive teacher feedback through online LMS, students ability to practice mastering material at their own pace, flexible expression of student learning, student self evaluation through online rubrics, problem-solving/inquiry-based learning, delivering instruction through multiple forms of media, and facilitating students through technology-based learning.

The concluded analysis of the third (sub) question provided results on how instruction was designed in the grade five one-to-one computing environment. Results identified that one-to-one computing allowed for instruction to be designed and delivered online. The netbooks were described as the tool that drove instruction and engaged students. Instruction was organized into both technology-based and non-technology-based characteristics. Technology-based characteristics included: online access for both students and parents, built in online assessment, collaboration through web-based tools (e.g. Skype), student online access to additional work, included audio and video, included links to online rubrics, organizational sheets and web-based resources, and allowed assignments to be handed in by uploading into LMS (Moodle). Non-technology-based characteristics included: well-planned around curriculum outcomes, step-by-step instruction, problem-solving/inquiry-based, grade level specific language and content, facilitated by teacher, and differentiated meeting various learning styles.

The fourth question (sub-question) concluded that many of the learning resources applied within the one-to-one environment were technology-based. Grade five students,

when given a choice, often chose to use technology-based resources to express their learning. Identified from the analysis were three processes relating to circumstance in which technology-based resources were used in the grade five learning environment. The first category is *teacher deliberately designed resources*: resources the teacher placed into instruction to assist student learning (e.g. audio recordings through Audio Boo). The second category is *student initiated resources*: resources identified by the student to assist in their learning (e.g. text to speech – iSpeech). The third category is *student unique learning resources*: resources identified by the teacher or other professionals to assist in student learning (e.g. word prediction – Fusion Writer).

Question (sub-question) five concluded that instruction can be designed to include differentiated instruction (DI) in a one-to-one grade five learning environment. Results of DI were achieved through instruction that was accessed on netbooks, allowing for different learning styles to successfully complete tasks. DI was not only achieved through this research, but it was identified that characteristics of technology-rich learning environments naturally allow for DI.

The first way DI was incorporated into the grade five learning environment was that it addressed important curriculum and focused on outcomes. The following strategies were identified to accomplish this: the UbD process was used, learning outcomes were provided for each task to students through online instruction, increased access to instruction through Moodle, and flexibility and options were provided in tasks for students to work at their level.

Engagement was the second strategy for incorporating DI into the grade five learning environment. Engagement was initially achieved by providing students with netbooks and other technology-based learning tools and resources. Well-designed online problem-solving/inquiry-based activities were identified as engaging for students. Students also found engaging: online group discussions, web-based activities (Voicethread) and collaborative activities with classmates and distant students through web-based tools (Skype, Google Docs).

A third method for the grade five learning environment to incorporate DI is identified as demanding. The grade five learning environment was demanding because instruction was outcome based. Teachers in the grade five learning environment felt it was important to provide students with the 'why' in the instruction. Constant assessment was occurring in the environment. Technology-based tools and resources allowed for teachers to constantly gather, assess, and provide responsive feedback on student work. Teachers' also had high expectations of the students in the grade five learning environment.

Scaffolding was the fourth method for DI to be incorporated into the grade five learning environment. Teachers were well trained and supported in the UbD process by the school division. The grade five one-to-one project was supported by a team including classroom teacher, administration, DIF and DLC. Scaffolding was built into the instruction allowing for a variety of approaches and flexible expression to be used to meet different student learning styles. One-to-one computing allowed students to use

text-based as well as alternate methods such as auditory and visual supports to get instruction.

The supplemental analysis that came out of this research study is independent learning. Not in terms of students working alone but knowing what to do if the teacher was not able to get to them right away. Also for students to be able to critically think about the next steps and problem solve when necessary. The classroom teacher viewed independent learning intrinsic for students to attain 21st century skills. A belief from the researcher is that well-designed instruction led to the ability for the teacher to facilitate instruction and work with individual or groups of students. This in turn led to deeper student learning which resulted in independent student learning.

To conclude, results of this research study support the idea that, "Students don't come to class with 'engagement' – it is created through instructional processes" (Stephenson, 2011).

Implications and Recommendations

Data gathered in this research study came from a grade five learning environment. Results were presented through a case study methodology, sharing the events which occurred. Although, not necessary for the purpose of this study, a comparison group may be useful for comparing results in future studies. It is thought, by the researcher, that primary levels including grades 1-3 may produce significantly different results. Primary grades deal with lower levels of reading and writing and therefore instruction will look

different compared to higher grade levels. Further research may be necessary to fully understand implications based on age and grade level of students.

As education progresses through a phase of transformation, this research study provides insight into a learning environment attempting to provide 21st century skills to varying learner levels. Members of the educational fraternity including directors, superintendents, coordinators, consultants, administrators and teachers are provided a recipe based on a case study of a grade five technology-based learning environment. The recipe, of this study, identifies specific ingredients which resulted in the findings presented in the research. Although it may be possible to alter the ingredients, one could learn from the events and experiences of this research study.

A theme which emerged out of this research study is how instruction through technology-based learning lead to independence in students. Further research may be necessary to better understand how instruction, designed for technology-based learning leads to student independence.

Another item that may require additional research is the journey educators must take in order to transform pedagogy towards technology-based learning. What kinds of supports are necessary for educators to be successful in their transformational journey? Is it necessary for school divisions and universities to form partnerships to help both practicing teachers and pre-service teachers get the skills required for technology-based pedagogy?

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Appendix A

Organizational Consent

The grade 5 class at Maude Burke Community School has been participating in a one-to-one computing initiative throughout the 2010-2011 school year. As a result of this initiative and with your permission, I would like to invite specific members of the Maude Burke staff to participate in a research project titled Constructive Chaos: A Case Study on Student Learning in a Grade 5 One-to-One Computing Environment. Please read this form carefully, and feel free to contact me with any questions you may have.

Researcher(s): Kirk Kezema, MEd candidate, Department of Curriculum Studies, University of Saskatchewan, Ph (306) 921-5860, supervised by Dr. Dirk Morrison, Associate Professor of Educational Technology and Design, Department of Curriculum Studies, University of Saskatchewan: phone (306) 966-6483.

Purpose and Procedure: The purpose of this research is to explore the enrichment of teaching and learning for providing 21st century skills to students in a grade 5 classroom. The research study focuses on the dynamic interactions of three distinct enrichment strategies including one-to-one computing, instructional design and differentiated instruction to distinguish how a student's learning environment can be enriched to accommodate 21st century skills.

Employing a qualitative research approach, using case study methodology the researcher will observe and interview discrete teachers and students associated with the one-to-one project in the grade 5 classroom at Maude Burke Community School. Student observations will be conducted during class time by informants including: classroom teacher, differentiated instructional facilitator (DIF) and digital learning consultant (DLC). Observational data will be collected through field notes and audio/video recordings. Semi-structured interviews will be conducted with participants of the one-to-one initiative including: classroom teacher, differentiated instructional facilitator, school principal and grade 5 students. The interviews with the classroom teacher, differentiated instructional facilitator (DIF) and school principal will be conducted at a time of their convenience. Interviews will be conducted by a NESD digital learning consultant (DLC) other than the researcher. Student interviews will be conducted at a convenient time, during school hours by the differentiated instructional facilitator (DIF) and digital learning consultant (DLC) other than the researcher. The interviews will be audio-recorded to ensure accuracy and transcribed. Transcriptions of the interviews will be provided to the interviewee for revisions, additions and deletions prior to analysis to ensure the interview transcript accurately reflects the individual's opinions.

Potential Benefits: Potential benefits of participation in this research are improved pedagogy and understanding of technology-based practices supporting 21st century skills. This study is useful to better understand technology-based teaching and learning allowing knowledge to be constructed and informed decisions to be made as a result of research findings.

Potential Risks: As a result of the research study subjects being from a small, closed group, they may be identifiable to each other, and to others who are familiar with this group of people on the basis of what they have said.

Storage of Data: Data collected from the research project will be safeguarded and securely stored by Dr. Dirk Morrison at the University of Saskatchewan for a period of 5 years, after completion of the study. This is necessary for the purpose of scholarly articles resulting from the research. After the five year time period, the data will be appropriately destroyed.

Confidentiality: Data from this research project may be published and presented at conferences; however efforts to keep names of the research study subjects private and secure will be made by providing pseudonyms.

Right to Withdraw: Participation in this research project is voluntary and if interviewed participants can choose to answer only questions they are comfortable answering. Participants can choose to withdraw from the research project at any time for any reason. If a participant withdraws from the research project any data collected from that participant will be destroyed at their request without any penalty or impact on their standing in the class or on their final grade.

Questions: If you have any questions about the research project, please feel free to contact the lead researcher Kirk Kezema (921-5860). This research project has been reviewed and approved by the University of Saskatchewan's Behavioural Research Ethics Board.

Follow-Up or Debriefing:

Upon request, interested participants of this research project will be provided with an electronic copy of the final thesis.

Consent to Participate:

Written Consent

I have read and understood the description provided; I have had an opportunity to ask and my/our questions have been answered. I provide consent for participants of the MBCS one-to-one initiative including the classroom teacher, DIF, school principal and grade 5 students to be invited to take part in the above mentioned research study. A copy of this Consent Form has been given to me for my records.

_____ _____

(Name of Superintendent) (Date)

_____ _____

(Signature of Superintendent) (Signature of Researcher)

Appendix B
Parental/Student Consent

The grade 5 class, in which your child is a member, at Maude Burke Community School has been participating in a one-to-one computing initiative throughout the 2010-2011 school year. As a result of this initiative and with your permission, I would like to invite your grade 5 student to participate in a research project titled Constructive Chaos: A Case Study on Student Learning in a Grade 5 One-to-One Computing Environment. Please read this form carefully, and feel free to contact me with any questions you may have.

Researcher(s): Kirk Kezema, MEd candidate, Department of Curriculum Studies, University of Saskatchewan, Ph (306) 921-5860, supervised by Dr. Dirk Morrison, Associate Professor of Educational Technology and Design, Department of Curriculum Studies, University of Saskatchewan: phone (306) 966-6483.

Purpose and Procedure: The purpose of this research is to explore the enrichment of teaching and learning for providing 21st century skills to students in a grade 5 classroom. The research study focuses on the dynamic interactions of three distinct enrichment strategies including one-to-one computing, instructional design and differentiated instruction to distinguish how a student's learning environment can be enriched to accommodate 21st century skills.

Employing a qualitative research approach, using case study methodology the researcher will observe and interview discrete students in the grade 5 classroom at Maude Burke Community School. Student observations will be conducted during class time by informants including: classroom teacher, differentiated instructional facilitator (DIF) and digital learning consultant (DLC). Observational data will be collected through field notes and audio/video recordings. Semi-structured interviews with students will be conducted during school hours by the differentiated instructional facilitator (DIF) and digital learning consultant (DLC). The interviews will be audio-recorded to ensure accuracy and transcribed. Transcriptions of the interviews will be provided to the interviewee for revisions, additions and deletions prior to analysis to ensure the interview transcript accurately reflects the individual's opinions.

Potential Benefits: Potential benefits of student participation in this research are improved pedagogy and understanding of technology-based practices supporting 21st century skills. This study is useful to better understand technology-based teaching and learning allowing knowledge to be constructed and informed decisions to be made as a result of research findings.

Potential Risks: As a result of the research study subjects being from the grade 5 classroom at MBCS, who all know each other, their individual opinions may be identifiable.

Storage of Data: Data collected from the research project will be safeguarded and securely stored by Dr. Dirk Morrison at the University of Saskatchewan for a period of 5 years, after completion of the study. This is necessary for the purpose of scholarly articles resulting from the research. After the five year time period, the data will be appropriately destroyed.

Confidentiality: Data from this research project may be published and presented at conferences; however efforts to keep names of the research study subjects private and secure will be made by providing pseudonyms.

Right to Withdraw: Participation in this research project is voluntary and if interviewed participants can choose to answer only questions they are comfortable answering. Participants can choose to withdraw from the research project at any time for any reason. If a participant withdraws from the research project any data collected from that participant will be destroyed at their request without any impact on their standing in the class or on their final grade.

Questions: If you have any questions about the research project or about your child participating in the research project, please feel free to contact the lead researcher Kirk Kezema (921-5860). This research project has been reviewed and approved by both the North East School Division and the University of Saskatchewan's Behavioural Research Ethics Board.

Consent to Participate:

Written Consent

My Child and I have read and understood the description provided; I have had an opportunity to ask and my/our questions have been answered. I provide consent for my child to participate in the research project, understanding that I or my child may withdraw consent at any time. A copy of this Consent Form has been given to me for my records.

_____ _____

(Name of Parent) (Name of Student)

_____ _____

(Signature of Parent) (Signature of Student)

_____

(Date)

_____

(Signature of Researcher)

Appendix C
Invitation to Participate

As a member of the one-to-one computing initiative at Maude Burke Community School (MBCS) you are invited to participate in a research project titled Constructive Chaos: A Case Study on Student Learning in a Grade 5 One-to-One Computing Environment. Please read this form carefully, and feel free to contact me with any questions you may have.

Researcher(s): Kirk Kezema, MEd candidate, Department of Curriculum Studies, University of Saskatchewan, Ph (306) 921-5860, supervised by Dr. Dirk Morrison, Associate Professor of Educational Technology and Design, Department of Curriculum Studies, University of Saskatchewan: phone (306) 966-6483.

Purpose and Procedure: The purpose of this research is to explore the enrichment of teaching and learning for providing 21st century skills to students in a grade 5 classroom. The research study focuses on the dynamic interactions of three distinct enrichment strategies including one-to-one computing, instructional design and differentiated instruction to distinguish how a student's learning environment can be enriched to accommodate 21st century skills.

Employing a qualitative research approach, using case study methodology the researcher will observe and interview discrete teachers and interview the differentiated instructional facilitator (DIF) and school administrator associated with the grade five, one-to-one project at MBCS. Teacher observations will be conducted during class time by informants including: DIF and digital learning consultant (DLC). Observational data will be collected through field notes and audio/video recordings. Semi-structured interviews will be conducted with participants of the MBCS one-to-one initiative including: classroom teacher, DIF and school principal. The interviews with the classroom teacher, DIF and school principal will be conducted at a time of their convenience. Interviews will be conducted by a NESD digital learning consultant (DLC) other than the researcher. The interviews will be audio-recorded to ensure accuracy and transcribed. Transcriptions of the interviews will be provided to the interviewee for revisions, additions and deletions prior to analysis to ensure the interview transcript accurately reflects the individual's opinions.

Potential Benefits: Potential benefits of participation in this research are improved pedagogy and understanding of technology-based practices supporting 21st century skills. This study is useful to better understand technology-based teaching and learning allowing knowledge to be constructed and informed decisions to be made as a result of research findings.

Potential Risks: As a result of the research study subjects being from a small, closed group, they may be identifiable to each other, and to others who are familiar with this group of people on the basis of what they have said.

Storage of Data: Data collected from the research project will be safeguarded and securely stored by Dr. Dirk Morrison at the University of Saskatchewan for a period of 5 years, after completion of the study. This is necessary for the purpose of scholarly articles resulting from the research. After the five year time period, the data will be appropriately destroyed.

Confidentiality: Data from this research project may be published and presented at conferences; however efforts to keep names of the research study subjects private and secure will be made by providing pseudonyms.

Right to Withdraw: Participation in this research project is voluntary and interviewed participants can choose to answer only questions they are comfortable answering. There is no guarantee that you will personally benefit from your involvement in the research study. The information that is shared will be held in strict confidence and discussed only with the research team. Participants can choose to withdraw from the research project at any time for any reason without penalty of any sort. If you choose to withdraw from the study at any time, any data that you have contributed will be destroyed at your request.

Questions: If you have any questions about the research project, please feel free to contact the lead researcher Kirk Kezema (921-5860). This research project has been reviewed and approved by both the North East School Division and University of Saskatchewan's Behavioural Research Ethics Board.

Follow-Up or Debriefing:

Upon request, interested participants of this research project will be provided with an electronic copy of the final thesis.

Consent to Participate:

Written Consent

I have read and understood the description provided; I have had an opportunity to ask and my/our questions have been answered. I consent to participate in the research project, understanding that I may withdraw my consent at any time. A copy of this Consent Form has been given to me for my records.

_____	_____
(Name of Participant)	(Date)
_____	_____
(Signature of Participant)	(Signature of Researcher)

Appendix D
Observational Protocol

Length of Observation: 90 minutes	
Descriptive Notes description of activities: • Verbal portraits of research participants • Reconstruction of dialogue • Description of physical setting • Accounts of particular events • Description of observer's behaviour	**Reflective Notes** Process, reflections on activities, and summary conclusions about activities for later theme development: • Method's of data collection and analysis • Ethical dilemmas and conflict • Observer's frame of mind • Emerging interpretations
	Sketch of classroom

Appendix E
Subject Interview Protocol

Subject Interview Protocol

Project: Constructive Chaos: Case Study on Student Learning in a Grade 5 One-to-One Computing Environment

Time of interview:

Date:

Place:

Interviewer:

Interviewee:

Position of Interviewee:

Purpose of Study/Interview:

Hello, thank-you for participating in this interview. I am going to explain the purpose and procedure for this interview. Do you have any questions before we begin?

The reason for this interview is to collect information on the one-to-one classroom you are currently involved with in grade 5. We want to better understand teaching and learning in a classroom setup like the one you have in grade 5. Through this interview we will be able to collect information from you to help us learn about the learning environment.

The interview will last approximately 30 minutes and consists of 10 questions, in which we will go through in sequential order. I will ask you the question and wait for your response. All responses will be kept confidential, so please answer the questions freely and truthfully. If you require clarification please ask. I will be audio-taping your responses so that I don't miss anything. Do you have any questions? Are you ready to begin with the questions?

Questions:

1. Explain the physical environment (space) of your grade 5 classroom.

2. How does the physical environment (space) of your grade 5 classroom differ from previous classrooms you have been part of?

3. Does your current grade 5 classroom allow you to learn any differently compared to previous classrooms? If so, how?

4. Do you see other students learning differently in your current grade 5 class compared to previous classrooms? If so, how is it different?

5. Are there any skills that you are learning, in this classroom, that you would find difficult to learn in a more traditional classroom?

6. Do you see your teacher, in the grade 5 classroom, teaching differently than in previous classrooms? If so, how?

7. What are some of the ways you or other students, in your grade 5 class, access learning resources (e.g. activities, lessons, assignments, information).

8. How are some of the learning resources (e.g. activities, lessons, assignments, information) designed (how they look) differently in your current grade 5 classroom compared to previous classrooms?

9. Are you motivated to learn by the type of learning environment offered in your grade 5 classroom? Explain why or why not.

10. Do you see yourself or other students behaving any differently in the grade 5 classroom compared to previous classrooms? If so, what do you believe to be the reason for the difference in behaviour?

(Thank the student for participating in this interview. Assure him/her of confidentiality of responses.)

Appendix F
Informant Interview Protocol

Informant Interview Protocol

Project: Constructive Chaos: Case Study on Student Learning in a Grade 5 One-to-One Computing Environment
Time of interview:

Date:

Place:

Interviewer:

Interviewee:

Position of Interviewee:

Purpose of Study/Interview:

Hello, thank-you for participating in this interview. I am going to explain the purpose and procedure for this interview. Do you have any questions before we begin?

The reason for this interview is to collect information on the one-to-one classroom you are currently involved with in grade 5. We want to better understand teaching and learning in a classroom setup like the one you have in grade 5. Through this interview we will be able to collect information from you to help us learn about the technology-based environment.

The interview will last approximately 60 minutes and consists of 10 questions, in which we will go through in sequential order. I will ask you the question and wait for your response. All responses will be kept confidential, so please answer the questions freely and truthfully. If you require clarification please ask. I will be audio-taping your responses so that I don't miss anything. Do you have any questions? Are you ready to begin with the questions?

Questions:

1. How does the physical environment, of the grade 5 classroom, differ from more traditional classroom environments?

2. From your perspective, can you explain how the arrangement of the grade 5 classroom's physical environment affects (benefits/hinders) student learning compared to more traditional classroom arrangements?

3. How has teacher pedagogy changed, in the grade 5 classroom, as a result of the technology-based learning environment?

4. How has the design and delivery of instruction changed, in the grade 5 classroom, as a result of the technology-based learning environment.

5. How do you see differentiated instruction being implemented into the grade 5 classroom compared to more traditional learning environments?

6. How, if at all, do you see current grade 5 students learning differently compared to more traditional learning environments?

7. Read the following description of 21st century skills (Partnership for 21st Century Skills, 2011):

   21st century skills represent the necessary student outcomes for the 21st century. Students need:
   - core subjects and 21st century themes
   - learning and innovation skills (critical thinking, problem-solving, communication, collaboration, creativity)
   -information, media and ICT literacy
   -life and career skills

   What, if any, 21st century skills do you believe are being taught in the current grade 5 classroom?

8. Do you believe there to be a difference in teaching 21 century skills through the use of technology-based learning environments compared to more traditional learning environments?

9. What skills do you see necessary for a teacher to be successful in a technology-based learning environment?

10. What can you say has been most important realization of implementing a technology-based learning environment?

(Thank the informant for participating in this interview. Assure him/her of confidentiality of responses.)

Appendix G
Beh-REB Certificate of Approval

UNIVERSITY OF SASKATCHEWAN

Behavioural Research Ethics Board (Beh-REB)

Certificate of Approval

PRINCIPAL INVESTIGATOR	DEPARTMENT	BEH#
Dirk Morrison	Extension Division	11-94

INSTITUTION(S) WHERE RESEARCH WILL BE CONDUCTED
University of Saskatchewan

STUDENT RESEARCHER(S)
Kirk Kezema

FUNDER(S)
INTERNALLY FUNDED

TITLE
Constructive Chaos: Case Study on Student Learning in a Grade 5 One-to-One Computing Environment

ORIGINAL REVIEW DATE	APPROVAL ON	APPROVAL OF:	EXPIRY DATE
16-Apr-2011	17-May-2011	Ethics Application Consent Protocol	16-May-2012

Full Board Meeting ☐ Date of Full Board Meeting:

Delegated Review ☒ Expedited Review: ☐

CERTIFICATION

The University of Saskatchewan Behavioural Research Ethics Board has reviewed the above-named research project. The proposal was found to be acceptable on ethical grounds. The principal investigator has the responsibility for any other administrative or regulatory approvals that may pertain to this research project, and for ensuring that the authorized research is carried out according to the conditions outlined in the original protocol submitted for ethics review. This Certificate of Approval is valid for the above time period provided there is no change in experimental protocol or consent process or documents.

Any significant changes to your proposed method, or your consent and recruitment procedures should be reported to the Chair for Research Ethics Board consideration in advance of its implementation.

ONGOING REVIEW REQUIREMENTS

In order to receive annual renewal, a status report must be submitted to the REB Chair for Board consideration within one month of the current expiry date each year the study remains open, and upon study completion. Please refer to the following website for further instructions: *http://www.usask.ca/research/ethics_review/*

Appendix H
New Brunswick Notebook Initiative Implementation Plan

- All 7,500 K-12 teachers given the option of receiving a personal notebook computer for professional home and school use while employed in the New Brunswick school system, to be distributed to all interested teachers by July 1, 2006;

- A comprehensive professional development implementation plan for all interested teachers and school administrators, delivered over the summer of 2006 and into the school year;

- Expansion of the current Dedicated Notebook Research Project to include all grade 7 students at the existing Dedicated Notebook Research Project schools;

- Continuation of 1:1 access to the notebook computers in September 2006 for the grade 8 students that were part of Phase I and II of the Dedicated Notebook Research Project and who will move to grade 9 at Grand Manan Community School, Leo Hayes High School (Fredericton), Kennebecasis Valley High School (Rothesay) and Rothesay High School;

- A further round of applications for schools to apply to be part of the Notebook Initiative, with a total implementation investment of $9.4 million in notebook computers, teacher-mentors and technical assistants and related equipment in the Government of New Brunswick's 2006-2007 budget;

- By September of 2006, 2900 grades 7, 8, and 9 students at 27 New Brunswick schools will have a notebook computer (Fox, Greenlaw, & MacPherson, The New Brunswick dedicated notebook research project: Final report, 2006).